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MEETING PREHISTORIC MAN

School of Archaeology.

Meeting Prehistoric Man

G. H. R. VON KOENIGSWALD

Illustrated with 38 photographs

and 48 drawings

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PRINTED AND BOUND IN GREAT BRITAIN
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ILLUSTRATIONS

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For
Luitgarde
and Felicitas

ACKNOWLEDGMENTS

The text illustrations are from original drawings by the author with the exception of those on pp. 29, 32, E. Dubois; 43, 45, 47, 52, D. Black; 49, 50, 204, W. Weidenreich; 141, de Hevesy; 143, 149, W. Le Gros Clark and L. S. B. Leakey; 155, R. Broom and J. Robinson; 155, 158, 159, 160, J. Robinson; 178, an old British Museum *Guide*; 198, Romer.

The photographs for the plates were taken by the author, with the exception of the following. *Facing* page 32, E. Dubois *top*, W. Weidenreich *bottom*; 49, W. Weidenreich; 113, American Museum of Natural History, NewYork *bottom*; 113, American Museum of Natural History, New York *top*; 204, F. Windels, Les Eyzies.

FOREWORD

DURING RECENT YEARS interest in the descent of man has strikingly increased. What was once a maligned and contested theory, rejected by many on emotional grounds, is beginning to emerge as a reality, an historical fact of tremendous significance, in the light of new palaeontological finds. Man is slowly discovering that he is not simply what he is, but what he has become.

There are sufficient scientific descriptions of the few finds on which concrete knowledge of our own early history rests. It is not the purpose of these lines to add to them. The majority of books, however, are content to do little more than catalogue the finds; very few authors have any personal feeling about the material with which they work. A kind fate allowed me to hold in my hand more finds and visit more prehistoric sites than I had ever dared to hope. I have roamed Java; entered the caves of Peking man; hunted through Chinese apothecaries' shops; visited the sites of prehistoric finds in South Africa; and gathered material in Oldoway Gorge on the Serengeti Steppe. These are the experiences I wish to record in this book, which should really be called *The Diary of a Palaeontologist*. But in committing them to paper I found it advisable to alter and add a good deal, to enable the reader without specialized training to follow me along the winding paths of palaeontology and prehistory.

I am deeply indebted to a very large number of people for their support and assistance in my investigations. Here I should like merely to pay homage to a few old friends who are no longer with us: Dr F. Berckhemers, the discoverer of the Steinheim skull, whom I had known since my school-days, when I used to set out on my bicycle during the summer

holidays to collect fossils; the kindly Professor W. Weidenreich, who took such an interest in my work on Java and with whom I had the good fortune to collaborate in Peking and New York; Dr J. C. Merriam, who, as President of the Carnegie Institution of Washington, generously supplied me with the means to pursue my researches; and the ever pugnacious, ever original and stimulating Dr R. Broom, the brilliant South African palaeontologist.

I thank my valiant wife and Miss Senta Jessen for all the patience and aid I received from them during the writing of this book.

Utrecht

Summer 1956

INTRODUCTION

The Skull Tree

MAN DID NOT ADDRESS his inquiries to the earth on which he stood until a remarkably late stage in the development of his desire for knowledge. And the answers he received to the questions "Where do I come from?", "What is man?", although they made him poorer by a few illusions, gave him in compensation a knowledge of his past that is vaster than he could ever have dreamed. For it emerged that the history of life was his history too, and that he, who imagined himself unique and isolated, was organically linked to all forms of life by countless ties. His greatness does not consist in being different from the animals that share the earth with him, but in being more than they and in being conscious of things of which his environment has no inkling.

Modern man's view of the world is largely dominated by the findings of natural science. This view has been formed only slowly, and as the result of a series of shocks, the severity of which we can scarcely appreciate nowadays. The first shock came when Copernicus discovered that our earth was by no means the centre of the universe, as had hitherto been generally assumed, but a planet of medium size rotating round the sun. This discovery deprived the earth, and with it man, of their central position, and therefore meant the end of geocentric thinking. Today we know that the sun, which to the ancient Greeks was still borne on a chariot across the vault of heaven, is much larger than our earth, and there is argument as to whether other planets are inhabited or inhabitable. Indeed, people are already designing spaceships that will enable us to pay a visit to other planets.

The second shock occurred in the field of biology. Without

any preconceived ideas, and not losing sight of the story of the Creation, Carl von Linné—or, as he is generally called, Linnaeus—divided plants and animals into great natural families according to their anatomical and morphological characteristics. Linnaeus thus created the modern system of classification. He invented the binary nomenclature, by which every plant and animal received one Latin name for its genus and another for its species. Henceforth biologists of every tongue could understand one another without difficulty. Questions of nomenclature do not have to be referred any farther back than the tenth edition of Linnaeus's *Systema Naturae*, 1758.

In the course of his conscientious researches Linnaeus realized that man is not an isolated creature, but a member of the great family of Primates. Here he is in mixed company, for this group includes the lemurs, monkeys, and anthropoid apes.

To Linnaeus man owes his Latin name *Homo sapiens*, wise man, from which we must infer that Linnaeus was an optimist. Oddly enough, Linnaeus believed that two sorts of men could be distinguished: in addition to *Homo sapiens* he also described *Homo troglodytes*, cave man. This is none other than the chimpanzee, the well-known African anthropoid ape, which of all apes actually is closest to man and which was regarded during the Middle Ages as a pygmy, without anyone's feelings being hurt.

Linnaeus's brilliant diagnosis proved irrefutable. It was again and again confirmed by studies in the fields of comparative anatomy, embryology, serology, physiology and psychology. Of the three great anthropoid apes, as already stated, the chimpanzee most closely resembles man; then comes the gorilla, likewise an inhabitant of Africa; and after this the orang-utan of Borneo and Sumatra. The name of the latter, which is taken from the Malay, means in fact "man of the woods".

For Linnaeus and his contemporaries the discovery of far-reaching anatomical similarities between man and the

anthropoid apes did not necessarily imply a direct family relationship, for the species were immutable entities and there were as many of them as were created at the beginning. His classification comprised the present animal and vegetable kingdoms. It therefore lay, so to speak, on one plane: his animals had no ancestors different in appearance from themselves.

Linnaeus's system of classification began to look quite different as geological research brought to light more and more animals and plants now no longer in existence. Now there were only two possibilities: either to cling to the immutability of species—in which case there would be no direct connexion between the the remarkable fauna of prehistory and that of today—or else to assume a gradual modification of the species. The first view was taken by the great Cuvier, who was a first-rate observer and the founder of mammalian palaeontology, but who got totally stranded on his catastrophe theory. The mutability of species was first recognized by Lamarck, but it met with little approval in expert circles and none among the general public. To begin with, his voice died away unheard, although he endeavoured at the same time to provide an explanation of the phenomena he had observed. His theory of the inheritance of acquired characteristics has proved, after long discussion, untenable.

It was reserved to another to present to the world the mutability, and thereby the dynamic of species, in a form so vivid that it could never again be lost sight of. This man was Charles Darwin—a name which, for his own and subsequent generations, became synonymous with progress and knowledge. His book, *The Origin of Species through Natural Selection*, first published in 1859, came like a thunderclap; the first edition was sold out on the day of issue.

As a geneticist who carried out practical experiments in breeding, Darwin took as his starting-point the variability of living species, claiming—and here he was a trifle biased—to have identified as the main factor in the genesis of new species

the "struggle for existence". Initially, Darwin did not express himself on the descent of man; but the ball had been set rolling, and "Darwinism" became the great rallying-cry in the domains of science and philosophy. Darwin's ideas were first consistently applied to man in Britain, notably by Thomas Huxley, and in Germany by Ernst Haeckel. Above all, Haeckel drew up a hypothetical family tree of man, whose bold construction—although it is greatly over-simplified—compels our admiration by its considerable degree of intuitive accuracy.

With the appearance of Darwin's book the anthropocentric period of our thinking, which is still not entirely superseded, was virtually at an end.

It is not our intention to discuss the extent to which Darwin's explanations were correct in every particular. A century ago palaeontology was still in its infancy, and little or nothing was known about the mysteries of heredity. Today genetics has become an independent science that seeks to track down the riddle of the variability of species by experiment. But we must not forget that in this domain the scientist cannot have at his disposal the geological ages within which evolution as such operates.

Darwin's doctrine of the variability of species has meanwhile been magnificently supplemented by the findings of geology and palaeontology. The latter science, in particular, has gained a decisive role in investigating the origin of man; palaeontology it is that, while studying the fauna of past geological epochs, simultaneously lays bare the history of man. Though we cannot expect palaeontology to provide concrete evidence concerning the origin of life, it has already made it possible for the evolution of numerous groups of animals to be traced back over an almost unimaginable span of time and broadly reconstructed by the aid of certain recognized laws. The geologist has discovered that each of the earth's strata contains relics of its own, and only its own, world of organic life. Naturally, only a small percentage of the fauna that once existed has left its remains to

us in one form or another. It is not so very long since the difference between the forms of life belonging to the various geological epochs appeared to us so great that tremendous catastrophes were thought to have periodically destroyed the existing fauna, after which a new fauna was created. Cuvier's catastrophe theory has now been abandoned: today we know that the transition from one fauna to another was far less abrupt than originally seemed to be the case, and that fauna and flora become all the stranger the farther back we go. Thus the picture of a continuous process of development forces itself upon us, an evolution whose temporal dimensions have only become clear to us since we have been able not merely to estimate but to measure the age of the various geological strata. It is scarcely thirty years since it first became possible to calculate the age of particular rocks with the aid of radioactive minerals. Our surprise at the results was much the same as that of the astronomers when they studied the firmament. At one time people thought the stars were suspended from the sky a short distance above the earth: today we know that they are many light years away from us. As late as 1650 Archbishop Ussher of Ireland said that our earth was created on October 4, 4004 B.C.! The great French naturalist Buffon was the first to deal with the age of the earth experimentally. He heated a large iron ball to incandescence and from the time it took to cool calculated the minimum age of the earth at 75,000 years. Later, geological methods were employed and attempts made to reckon the earth's age from the mean thickness of the sediments and the salt content of the oceans; this produced a figure of between 800 and 1,000 million years. Not until the radioactive method was employed did it emerge that all these estimates fall far short of the truth. The oldest rocks we know have an age of 2,000 million years. No trace of life is to be found in them. Life must have begun about 800 to 1,000 million years ago. The Cambrian formations, dating from approximately 550 million years ago, acquaint us with the first communities

of larger animals. The word "larger" is perhaps inappropriate here, for although all phyla of the invertebrates known today are already represented, the vertebrates are still missing; the latter first appear during the next period in the shape of primitive fishes.

Slowly evolution proceeds. We can see how quadrupeds developed from primeval fish with tassel-shaped appendages. Various examples of the transitional forms between fish and quadrupeds have been found during recent years. Amphibians are the ancestors of reptiles, and a small group of these creatures constitutes the bridge to the mammals. To take a small but important characteristic: all reptiles still have several bony elements in the lower jaw, but all mammals have only one. In the transition from reptile to mammal the bony parts of the lower jaw that had become superfluous did not simply disappear, but became detached from the complex of which they were previously a part and now form the mammal's intricate ear. Hence *all* reptiles possess only one ear-bone, while *all* mammals—including man—have three. In the case of every single human bone it is possible to show how it developed from the differentiation of the primitive bone elements of lower mammals. However exalted man may feel himself to be, comparative anatomy demonstrates that he is linked by his body to the animal kingdom. Hence it is possible to speak of a "prototype" of the vertebrates and at the same time to appreciate the high degree of specialization; from this standpoint, therefore, we can establish man's position in the zoological system.

The development of organic life must be understood as a process of astonishing vitality and delight in the proliferation of forms, only limited by the opportunities afforded by the environment and by the natural selection of the best adapted forms. There has been a great deal of argument as to how far evolution really means evolution to a higher level, for the word "higher" contains a distinctly human value-judgment.

But in my opinion there can be no doubt about it. Fish, with very few exceptions, are restricted to the water. Amphibians, although they live mainly on the land, still need water for reproduction, since their larvae have to remain in the water until they are able to move about on land. The reptiles are in every way adapted to life on land, but their lack of hair and of thermo-regulation makes it impossible for them to advance into the Arctic regions. Warm-blooded mammals are well able to adapt themselves to the Arctic environment.

As we see, new types come into being, able to adapt themselves to a large extent to all the conditions obtaining on earth. The most amazing phenomena in this respect are the cave-dwelling forms and the parasites that live on other animals; every possibility is utilized. There is vast prodigality that often goes beyond what is strictly necessary: this is most beautifully exemplified in the many variations in the shape of antelopes' horns, the gorgeous colours of birds, and the patterns on the wings of butterflies. In the days when palaeontological material was still very scanty it was believed that the various recognizably related groups of organisms had followed a more or less straight line of evolution, to which the name orthogenesis was given. The term was intended to indicate that the end-product of any form was largely determined in advance by its inherent trends. This standpoint had to be abandoned when more material came to light and it became evident in several cases that this apparently purposeful evolution was only an illusion due to insufficient data. Nature, as Simpson has expressed it, is an opportunist and takes every chance that offers itself. When conditions of life change, organisms too partially adapted die out, and their places are taken by those less specialized. Again and again throughout the earth's history we see how life reacted to the great phases of mountain formation by the explosive production of new types.

On what relics is the knowledge of our prehistory based? The farther back we go the scantier become the cultural remains

capable of telling us something about the men of those times, and quite soon we enter periods in which not only the culture but even the physical type are so different from those of modern man that, formally speaking, we are looking at a different species. Anthropology and palaeontology have the last word, and all we find at the older levels, in which we cannot discover the slightest trace of human culture, are skeletal remains. Skulls and jaw-bones are the most important things here, and, apart from morphological characteristics, we are able to establish by measurement the factors which cause them to differ from modern man and at the same time to plot the course of human evolution as such. This is most manifest in the development of the most human of man's organs, the brain. And when, in the course of our discussion, we keep referring to the cranial capacity expressed in cubic centimetres, we are in fact dealing with something much more than can really be stated in figures.

To the palaeontologist, then, the evolution of life—apart from its theoretical explanation—is a matter of experience and fact confirmed anew by every fossil found. In view of the complexity of the problem and the incompleteness of the material, it is easy to point to what we do not yet know. Today we are well informed about numerous details of the evolution of many groups of animals—the horse and the elephant are good examples. No living creature has been at all times what it is today, and this includes man. His story is bound up with the story of life. Even if we had not yet found a single fossilized relic of man we should still know that fossil man was a reality.

Fortunately we need not be too pessimistic here. Admittedly the available material is still limited, but it is unambiguous. If we leave out of account Neanderthal man—who is our immediate precursor and whose remains are repeatedly coming to light, even if they are not copious—the relics of our forebears which have so far come into our possession could be spread out on a medium-sized table. The majority of these finds have only been made during the last thirty years, and they have not

yet been sufficiently studied. It is these recent finds which this book aims to bring closer to the reader.

The most vivid way of presenting the relationships between allied forms from different geological periods is probably the much praised and much maligned family tree. It is an auxiliary —no more: its touching simplicity may all too easily blind us to the complexity of the interconnexions. It must not be forgotten that in the family tree we bring together forms that lived in different regions, often in different climates, and which must certainly have unfolded at very different rates. In most genealogical tables the various forms are simply connected by a straight line, tending to create the illusory impression of rectilinear evolution. These lines should really be curved and this means, metaphorically speaking, that looking backwards we cannot see our forerunner, who is hidden behind a bend: hence man all too readily gains the impression that he has always existed. . . .

Since we cannot properly say anything about the shape and form, that is to say, about the outward appearance of prehistoric man—apart from certain very hypothetical, though well-meant reconstructions—we have come to represent the human family tree by a series of skulls. Such a presentation has always reminded me forcibly of the skull tree of primitive head-hunters, who nail the captured heads of their enemies to a tree, which is thought by ethnologists to represent the tree of life.

And now let us go on a skull-hunt.

JAVA I

The Trinil Stone

WE HAVE SPENT the night at Madiun, the sleepy little provincial town on the border between Central and East Java. We arrived the previous day from Bandung, high and cool in the mountains of West Java, after crossing the green and fertile plain of Leles and passing fire-belching Merapi. And now early in the morning, before the heat descends on the land like a suffocating cloud, we are on our way to Trinil.

The smooth, broad high-road leads westward, lined on both sides with flat-topped *renbo* trees looking as though a giant gardener had snipped off their upper foliage with a huge pair of shears. Behind Madiun two great mountains, Lawu and Wilis, stand out clearly, dominating the landscape for miles around. They tower up from the plain, the former some 10,000 feet high, the latter over 8,000 feet. They are green and wooded right up to the summit, but their shape gives away their nature—volcanoes. These mountains are both a boon and a bane to Java. They are dangerous, mortally dangerous, when the molten lava and the rain of hot ashes devastate the countryside. But the volcanic ash brings fertility, and Java's dense population would be unthinkable without it.

To our right looms the range of the Kendeng Hills, wooded with teak trees. A small eminence, little more than a thousand feet high—that is the Pandan. And yet this is the petrified lava core of a huge volcano which, several hundred thousand years ago, may have been as big as Mount Lawu. A volcano that is played out.

The road is flanked on both sides by irrigated rice-fields carefully divided off by narrow banks of earth. These *sawahs* call for a very complicated system of canals; it is more than one

man can cope with, and the village community as a whole is responsible for the irrigation and distribution of the fields. Between the *sawahs* stand fields of tall sugar-cane, and every now and then, beneath coco-nut palms, a small village. The country is so densely populated that there is not a house from which another house is not visible.

A few big, grey water-buffaloes are wallowing in a pool by the roadside, eyeing our car suspiciously. They are often extremely aggressive towards Europeans—it is said that they cannot bear our smell—but they put up with anything from the little naked Javanese boys who sit on their broad backs.

We do not see many other animals. A few emaciated cows, a few lethargic zebus with their humps. Little hens, called *ajams* by the Malays, which do not deserve the title of "chicken" even when roast; but no pigs, for the people are Moslems. For the same reason dogs are represented only by a few suspicious and undernourished specimens.

The men go to market with heavy loads suspended from both ends of a bamboo pole, the centre of which rests on one shoulder. They walk with a lilting gait, barefoot, but with their heads covered. First comes a headcloth, which is not taken off even indoors, and on top of this a straw hat, the shape of a shallow funnel, as a protection against the hot sun. The women carry their shopping under their arm, slung in a long narrow cloth—the *slendang*—which is firmly knotted over one shoulder. Here in Central Java the colours of the clothes are sombre and subdued. There is a great deal of black and blue for blouses and jackets, and blue or brown for the *sarong*, the broad cloth tied round the waist in place of a skirt or trousers. Like the colours, the people here are quiet and serious. How different things are in West Java with its gay colours and laughing faces! The pattern of the *sarong* is strictly graded according to family, rank and origin, and tells the Javanese as much as the kilt does the Scotsman.

We approach Ngawi, a little district-town. One branch of

the road leads to a pool containing sacred turtles; every time I pass by here I vow to visit this remarkable place, and every time I have failed to do so for one reason or another. Ngawi itself has nothing to offer the European. In the centre there is a large square, as in most Javanese villages, the so-called *aloon-aloon*. In the square we always notice two old *waringin* trees, one male and one female. These many-branched, many-rooted trees are considered holy, and no Javanese would dare lightly to cut down a *waringin*.

Ngawi is soon behind us, and a few miles farther on we turn right on to a narrow country road. After about ten minutes we come to a *kampong*, as a village is called in Java; hanging on one of the houses is a wooden signboard bearing the name "Trinil". The road ends abruptly on the edge of a high river-bank. Below us flows the Bengawan Solo, the great River Solo. Its waters are brown and murky; buffaloes loll in the water, and this Cloaca Maxima of Central Java carries away all the refuse of the numerous villages along its banks. But this does not hinder anyone here from bathing in the river or cleaning his teeth with its water. The women by the bank are standing up to their waists in the water peacefully doing their washing. Nobody here has yet heard of bacilli and similar fiendish inventions of the West. It is true that more than half the children do not survive the first year of life, but the remainder are hardened and immune.

The environment can scarcely be called picturesque. A tiny hamlet, neither more nor less attractive than thousands of others in Java; the brown river deeply incised; on the other side wretched fields, a few houses, and in the background the dark fringe of Kendeng Forest. People have been digging on the other bank; the washed-out-traces of an old sand-pit, now half under water, are clearly visible. A strange place for a sand-pit.

Meanwhile women and children have caught up with us; as soon as our car appeared they vanished into their houses, to set

out after us with little baskets and coco-nut bowls. The wares they try to sell us are curiously shaped black stones. Looking closer we see that these stones are bones, teeth and pieces of stags' horns, dark brown and fossilized.

To many people fossils are something incomprehensible; they have frightful Latin names no one can pronounce and which frequently appear senseless when translated. And yet they are the only documents of the life of our geological past. They have fascinated me from my earliest youth; already in my school-days I started a collection not only of shells and ammonites, but above all of bones and teeth; and before I had even taken my school-leaving certificate I was firmly resolved to study geology and palaeontology. I clearly recall having read an account of sharks and three-toed horses supposed once to have lived in Rhenish Hesse; and a romantic book by O. Hauser, *Man 100,000 Years Ago*, had a particularly strong influence on me. It was not easy for me to keep to my purpose —my university days corresponded with the inflation period— but I managed it. I finished my studies at Munich in the spring of 1927 and thereafter became an assistant at the museum. In the autumn of 1930 my old teacher, Professor F. Broili, received an inquiry from Holland: would one of his students be willing to go to Java as a palaeontologist for the Geological Survey? He asked me; I jumped at the chance; and in January 1931 I landed at Tanjung Priok, the port of Jakarta.

And so the contents of the little baskets are nothing unusual for me. They are the remains of animals that once lived in Java and are today largely extinct. In a few cases only the species is extinct, having been replaced by others.

The little antlers belong to axis deer, small deer with white spots, such as still live in India. Big columnar teeth reveal the bovines: the larger ones belong to a huge water-buffalo, similar to the modern water-buffalo but with much longer horns; the smaller are those of the banteng, the wild ox of Indonesia, which is still to be found in the remote forests on the south

coast of Java, shy and difficult to hunt, aggressive when wounded. Pigs' teeth, with the many tuberculations typical of omnivorous animals, are easily recognized; and large versions of these come from the pig's giant cousin, the hippopotamus. Today hippopotamuses are confined to Africa, but as fossils they also occur in Europe, India and Java. The Asiatic group is distinguished from the African by the possession of six incisors, of which the latter has only four. Other large teeth with sharp ridges belong to the rhinoceros, which is now almost extinct in Java. The Malay word for this animal, *badak*, appears in many place-names and proves how widely distributed this primeval monster once was. One of my colleagues, Herr Harting, found the beautiful fossilized upper jaw of a rhinoceros directly behind our swimming-pool at Bandung.

A few tooth fragments call attention to themselves by their unusual size. There are the long, flat lamellae of elephants' teeth; although elephants no longer live on Java they still occur on the neighbouring island of Sumatra. Other, very similar teeth exhibit low ridges. They belong to the stegodon (from *stegos* roof, and *odos* tooth, i.e. the "roof-toother"), a forerunner of the elephant that has not been found either in Europe or America. It is a genus typical of Eastern Asia, though a few teeth have recently been discovered in Africa.

To the palaeontologist and zoologist the stegodon is an animal of quite special importance. Its precursor was the mastodon, a pig-toothed primitive elephant, whose remains have been found in many places in Europe and North America. The stegodon occupies an intermediate position between these low-toothed mastodons and the high-toothed modern elephants. Mastodon–stegodon–elephant together form an evolutionary series such as we nowadays recognize in many other groups of animals.

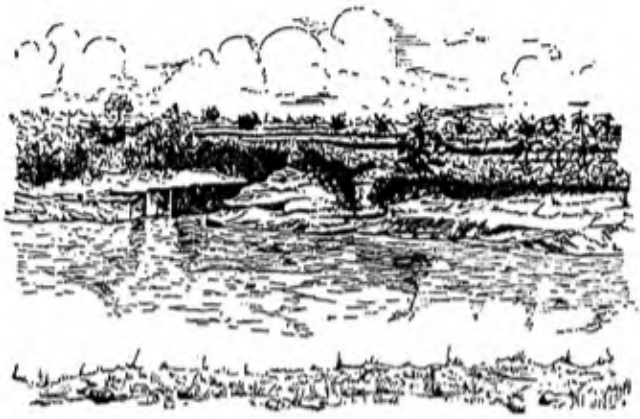
More women and children appear: the supply of fossils seems inexhaustible. Suddenly our eyes light on a stone bearing the cryptic inscription: "P.e. 175 m ONO 1891/93".

Few who make the pilgrimage to this lonely spot on the River Solo are unaware of the significance of this remarkable inscription. It stands for: "*P*ithecanthropus *e*rectus wurde *175 m* Ost*n*ordo*s*t von dieser Stelle gefunden in den Jahren *1891/93*" (*Pithecanthropus erectus* was found 192 yards east-north-east of this spot in the years 1891/93).

1 The Trinil stone

Pithecanthropus erectus! The erect ape-man of Java, the "missing link", the most famous, most discussed, most maligned fossil. One cannot open a single book on anthropology, the prehistory or comparative anatomy of man, palaeontology or geology, without at least finding his name. A primitive man or a specialized ape? No other palaeontological discovery has created such a sensation and led to such a variety of conflicting scientific opinions. It was this find that brought the problem of the coming of man before the public.

So this is where the find was made. Our gaze sweeps across to the other bank, to the excavation site—now half under water—and we begin to look at this peaceful landscape with other eyes.



2 Trinil: the site of the first *Pithecanthropus* skull

From Darwin to Dubois

DUBOIS'S FIND CAME at just the right moment: at a time when the conflict around Darwinism was at its height. For the scientific world it constituted the first concrete proof that man is subject not only to biological but also to palaeontological laws—this is really self-evident, for palaeontology is historical biology.

Darwin, who had set the ball rolling, initially avoided any detailed discussion of the origin of man in his classical work, leaving the field to Thomas Huxley and Ernst Haeckel. Huxley, whose book on man's position in nature was published in 1863, investigated the affinities between man and the anthropoid

apes. He discovered that, anatomically, the distance between man and the anthropoid apes was less than that between the latter and ordinary apes. He had great difficulties with the British clergy, successfully defending his standpoint in a dramatic disputation with the Archbishop of Canterbury.

Haeckel argued—not always felicitously—on biologico-philosophical grounds, and in his *Natural History of Creation* (1866) proceeded to formulate a complete family tree of man, in which he distinguished twenty-two genealogical stages. He began, biologically, with the protozoon and ended with himself and his contemporaries. We must admire the creative imagination with which he sought to reconstruct man's earliest history. Let us not forget that in his day almost nothing was known of fossil man. The Neanderthal skull had already been found, but the famous anatomist Rudolf Virchow refused to see in the Neanderthaler anything other than a variant individual of our species, and by his authority he prevented general recognition of this discovery. In Haeckel's time almost nothing was known of fossil anthropoid apes either.

There is no need here to go into the whole "family tree" devised by Haeckel. The twentieth genealogical stage consisted of the anthropoid apes (*anthropoides*); the twenty-second comprised humans (*homines*). In between, as stage twenty-one, came the stage of "ape-men (*pithecanthropi*); speechless primitive men (*alali*). Absence of articulate human verbal speech." We can feel here the influence of the philologist and philosopher von Schleicher, who was a friend of Haeckel's. In a well-known painting that still hangs in the Haeckel Museum at Jena, Gabriel Max has endeavoured to breathe life into this *Pithecanthropus alalus*. It is a very remarkable picture: under a tree a woman with long, lank hair sits cross-legged suckling a child. Beside her stands her husband, fat-bellied and low-browed, his back thickly covered with hair. He looks at the spectator good-naturedly and unintelligently, with the suspicious expression of an inveterate toper. It must have been

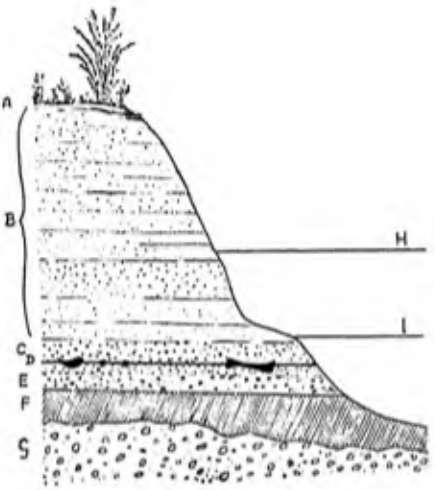
a very happy marriage: his wife could not contradict him, for neither of them could speak.

Relics of fossil man came to light but slowly. In 1882 two Neanderthal skulls were disinterred near Spy in Belgium, together with remains of the mammoth and woolly rhinoceros. Neanderthal man began gradually to assert himself.

Then a young Dutch doctor, Eugene Dubois, who had been very strongly influenced by Darwin and his followers, resolved that he himself would make some contribution to the knowledge of fossil man. In 1887 he had gone as a government physician to what were then the Dutch East Indies, and had begun to excavate caves around Padang on Sumatra in his spare time—naturally without much success. In Europe man was compelled by the cold of the Ice Age to seek shelter in caves, and so the archaeologist has little difficulty in finding a place where he can successfully dig. It is different in the tropics. Here the caves are the dwellings of bats, snakes and the great monitor lizards, and of course also of evil spirits. Hence they are not generally inhabited by men, and culture-levels and skeletons are found only rarely.

But Dubois did not give up. In 1888 he published an article *On the need for an investigation into the existence of an Ice Age fauna in the Dutch East Indies, and especially in Sumatra.* He pointed to the interesting fauna unearthed in the Siwalik Hills at the foot of the Himalayas and to the possibility that a similar fauna might also be found in Indonesia. In his view, Europe and the northern latitudes as a whole were out of the question as the cradle for mankind, on account of the unfavourable influence of the Ice Age. "Since all apes—and notably the anthropoid apes—are inhabitants of the tropics, and since man's forerunners, as they gradually lost their coat of hair, must certainly have continued to live in warm regions, we are inescapably led towards the tropics as the area in which we may expect to find the fossilized precursors of man." He seems to have been particularly influenced by Rudolf Virchow,

whom he quotes verbatim: "Large areas of the earth are still completely unknown as concerns their fossil treasures. Amongst these are precisely the habitats of the anthropoid apes: tropical Africa, Borneo and the neighbouring islands are still totally unexplored. A single discovery may change the whole state of affairs."



3 Dubois's drawing of the *Pithecanthropus* site at Trinil. The finds come from Level D. H = high-water mark during the rainy season

The First Skull

"A SINGLE DISCOVERY may change the whole state of affairs." What an impression this sentence must have made on young Dubois. And he was convinced that he would make this discovery.

In fact, Dubois's article drew the government's attention to him, and we read in the first quarterly report of the Mining Authority for 1889 that from March 6, 1889, Mijnheer

M. E. T. Dubois is commissioned to undertake palaeontological investigations for this Authority in Sumatra.

Dubois set to work. He dug in various caves, found the bones of elephant and rhinoceros, many teeth of orang-utan, which no longer occur in Central Sumatra . . . but no trace of man. Then a remarkable coincidence came to his assistance. While he was looking for skulls in Sumatra, one was found in Java. It lay in a cave opened up during work in the Wadjak marble quarry near Tulung Agung on the south coast of Java. And on April 14, 1890, Dubois received official permission to extend his investigations to Java. He went to Wadjak himself and had the great good fortune almost at once to find the remains of a second skull. His anatomically trained eye recognized that this was neither an *extinct* human type nor a Javanese. No sooner had he found it in 1890 than he came to the conclusion that he was looking at the relic of a human race that must have been related to the Australians and Papuans. But he left a scientific examination of this find until 1922.

In the eighteen-nineties only very few fossils had come to light on Java. Most of these had been collected by the Javanese painter Raden Saleh, and sent to Leyden Museum for examination by Professor Martin. Dubois began investigations on his own account, first in the neighbourhood of Pandan, the same mountain we saw in the distance on our journey to Trinil. He found every conceivable kind of fossil, including teeth of the tapir, which is now extinct on Java, and on November 24, 1890, he discovered a small fragment of a human mandible. Unfortunately the fossil was very badly preserved, and the teeth were broken off.

From Pandan he continued his search in a westerly direction, and in August 1891 he discovered Trinil. It was at the end of the dry season, the river was low and the fossil-bearing strata easily accessible, and he had soon collected a small fauna. He announced as his most important find an upper back molar, which he believed could be attributed to a chimpanzee.

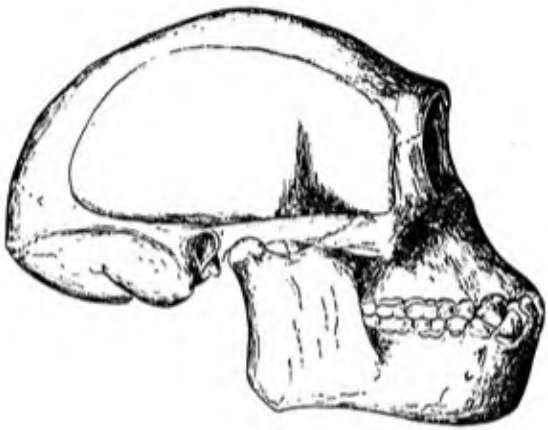
Although nowadays the chimpanzee is confined to Central Africa, remains of apes resembling the chimpanzee had at that time already been reported from the Siwalik levels in India.

A month later he found a shallow skull-cap with a very pronounced supra-orbital ridge. This find, too, was thought to belong to a chimpanzee. When he resumed digging in the dry season of the following year, he found fifteen yards upstream in the same level a complete femur, which, as he at once recognized, resembled that of a man and was likewise adapted to an upright posture. But he was still convinced that he was dealing with a creature resembling the chimpanzee, and he believed that the tooth, the skull-cap and the thigh-bone belonged not only to the same species but to the same individual.

Dubois could publish the results of his field work and preliminary observations only in the quarterly report of the Mining Authority, and so they scarcely reached the scientific world. Not until some years later, in 1894, did an initial scientific description with illustrations and measurements appear. It was written in German and bore the sensational title, *Pithecanthropus erectus, a Man-like Species of Transitional Anthropoid from Java.* The name *Pithecanthropus* Dubois must have consciously adopted from Haeckel, who, as we have seen, introduced it in his *Natural History of Creation.* "*Pithecanthropus*", he writes, "is the transitional form which, in accordance with the doctrine of evolution, must have existed between man and the anthropoids."

We can scarcely imagine today the effect the publication of the finds and Dubois's bold deductions must have had on the scientific world. All the great anthropologists of his day had to come to terms with his findings; they were accepted by many, but others rejected them. Among the latter we once more find Rudolf Virchow—the same who refused to accept the Neanderthaler—and a great many people took their line from him. Doubt was even cast on the connexion between the individual finds.

Pithecanthropus became Dubois's destiny. It was his discovery, his creation, his exclusive possession; on this point he was as unaccountable as a jealous lover. Anyone who disagreed with his interpretation of *Pithecanthropus* was his personal enemy. When his ideas failed to win general acceptance he sullenly withdrew, growing mistrustful, unsociable and eccentric. He showed his finds to hardly anyone, and at night he used to



4 Dubois's first reconstruction of the *Pithecanthropus* skull (1896)

hear burglars prowling round the house, bent on stealing his *Pithecanthropus*. If anyone came to his door in whom he scented a colleague, he was simply not at home.

I myself, together with my wife, visited Dubois in his house at Haarlem, in October 1936. He was stated to be ill and unable to see anyone; but when I gave my name I was allowed in, since I came fresh from Java. Dubois was sitting quietly in his living-room, a big, broad-shouldered, imposing man with a stereotyped, almost embarrassed smile round his mouth. When I cautiously made my request to be allowed to see his original finds (which had been deposited for some years in Leyden

The skull-cap of *Pithecanthropus erectus* discovered at Trinil by E. Dubois in 1891

For comparison: the skulls of modern man (*right*) and a female gorilla (*left*)

The evolutionary history of the elephant: the tooth of the stegodon (*centre*) stands midway between that of the mastodon, consisting of a few ridges (*above*), and that of the elephant, made up of high lamellae (*below*). All finds from Java

Museum, where they were safer than at Haarlem), I received permission only after he had assured himself in an open telephone conversation with his assistant that I had not already tried to force my way into the sacred halls at Leyden behind his back.

The following day, in Leyden, the double safe was opened for me, and I was allowed to take the finds themselves in my hands. The fragments were dark brown in colour, weighty, and heavily fossilized. The smooth, round skull-cap was deeply corroded by acid ground-water. The other parts of the skull seemed also to have had deep holes and a rough surface, but here Dubois had made the surface smooth by rubbing in a pulp resembling papier mâché to facilitate the making of casts. The convolutions of the brain were clearly imprinted on the inside of the skull-cap. Holding the hollow, fragile object in one's hand—during casting it is always filled—one is particularly conscious of its fragmentary nature. It is no more than a calvarium from which the most important parts are missing —the temporal region, which is essential to an accurate assessment of its nature. This must be made perfectly clear in order fully to understand the conflict that raged round *Pithecanthropus*. The crux of the matter was the interpretation of an incomplete fossil. Was this shallow skull with the simian supra-orbital ridge really that of a human being? There could, of course, be no doubt as regards the thigh-bone. But did the two finds really belong to the same creature?

That morning in Leyden was decisive for me in many respects. I was in great difficulties at the time. The economic situation in Java was less favourable than it had been a few years earlier, and the investigations originally begun with great idealism were abruptly broken off. At the end of 1935 my post as vertebrate palaeontologist with the Java Geological Survey had been terminated, and I ought properly to have looked for a new position elsewhere. But that morning it became clear to me that I must return to Java.

The dispute over *Pithecanthropus* had evoked a flood of publications. Dubois himself began to overburden his few finds with theories. He tried to establish a fixed formula for the relationship between brain weight and body weight. In his opinion his *Pithecanthropus* finds belonged to a female individual possessing a cranial capacity of 908 c.cm. (no more and no less), 5 feet 8 inches tall, and weighing 16 stone 5 lb. All this, of course, was based on the assumption—which Dubois regarded as irrefutable—that all his finds belonged to the same individual. Belief in this view was severely shaken when, in 1932, the remains of three further thigh-bones were discovered in his collection, and in 1935 another one! But this did not worry Dubois.

That the femur and the calvarium really come from the same level has meanwhile been proved by fluorine analysis: the fluorine content of bones that have lain for the same length of time in ground-water is always identical. Weidenreich believed nevertheless that the skull-cap and the thigh-bone might have belonged to two different types of human (the thigh-bone to modern man), but this is extremely unlikely. In 1891 Dubois interpreted an upper molar from Trinil as belonging to *Pithecanthropus*; but his book of 1926 contains illustrations of three teeth, two very large molars and one small lower premolar. Weidenreich was the first to point out that, by their proportions alone, these teeth could not possibly have come from the same jaw. Today we know that only the lower tooth belongs to *Pithecanthropus*. The two upper molars originate from a fossil orang-utan, many of whose teeth have now been found in Java. It therefore becomes manifest on what shaky ground Dubois erected his hypothetical building, and we can only wonder at the boldness and tenacity with which he defended his *Pithecanthropus*.

A glance at Dubois's finds was enough to show that only further discoveries could bring a definitive solution of the *Pithecanthropus* problem. After Dubois left for Holland, fossils

continued to be collected for a few years at Trinil without any significant finds coming to light. Dubois had meanwhile become professor of mineralogy at Amsterdam, and although it would have been easy for him to return to Java he seems never to have thought of doing so.

After the scientific world had waited many years in vain for new finds from Java, Emil Selenka, professor of zoology at Munich University, resolved to go to Trinil himself and excavate further. He was not unknown in Holland, where he had worked as a zoologist at Leyden University from 1868 to 1874, and from 1887 to 1889 he had made a prolonged journey to Eastern Asia, in the course of which he had visited Java and Borneo. His main concern was the anthropoid apes, but he was also interested in the origin of man. His Dutch friends obtained a permit for him, and his expedition was to have started digging at Trinil in 1906. The Academy of Sciences, Berlin, put up the money, and Munich University also contributed. Selenka died before the expedition could set out. But his energetic wife, Frau Margarete Lenore Selenka, assumed leadership of the expedition and sailed for Java at the beginning of 1907, accompanied by the German geologist Elbert and the Dutch mining engineer Oppenoorth.

This expedition roused Dubois into activity. The scientific world had been waiting eagerly for a study of his finds, and in 1903 the Dutch Minister of the Interior, Dr Kuyper, had announced officially that the final description and publication of the fossils collected by Dubois could be expected within three years. But no description appeared.

Selenka's plans compelled Dubois at last to break his silence. In 1907 and 1908 respectively two short digests on the Trinil fauna were published, without measurements and without illustrations of any of the finds, the first in Dutch, the second —to all intents and purposes a repetition of the first—in German. In these the various species of fossil mammals on Java were briefly described. Dubois gave them all new Latin

names, without paying any attention to existing descriptions. He treated all the rules of nomenclature in such a cavalier fashion that he called a Trinil tiger *Felis groeneveldtii* in the first publication, and in the second—no doubt after he had decided, for some reason, to withdraw this honour from Mr Groeneveldt—*Felis trinilensis*. Today this whole nomenclature has proved to be quite senseless: we know that it was the jaw of an ordinary tiger.

The spot at which the Selenka expedition pitched its camp is still easy to find. It is strewn with innumerable broken beer bottles, testifying to the expedition's thirst. Excavations at Trinil yielded a rich harvest. Hundreds of stags' horns, the remains of a small antelope—which was called *duboisia* in honours of Dubois—and the bones of buffaloes, bantengs and those remarkable elephants, the stegodons, were found there. A mass of material was unearthed—but no *Pithecanthropus*. A single mandibular tooth found on the surface near Trinil was erroneously described as the tooth of a *Pithecanthropus*, but certainly belongs to modern man.

The members of the Selenka expedition conscientiously described the Trinil finds and made excellent illustrations of them, thus greatly enriching our knowledge of the Javanese fossil fauna. Furthermore, all the finds came from one site (Dubois's collection comprised finds from various sites and various ages, which are very inadequately distinguished, because some of the labels got lost), and thus afforded the first picture of the whole *Pithecanthropus* level. But *Pithecanthropus* remained an enigma.

Although no more digging was done at Trinil for the time being, the population were for ever finding bones and teeth washed up after floods. Many visitors came to this lonely spot on the River Solo, hoping to pick up a new *Pithecanthropus* skull for a few cents. And it almost looked as though someone had really drawn the winner in this bone lottery, when on December 27, 1926, the Batavia papers announced that

Dr C. E. J. Heberlein of Surabaya had discovered a new *Pithecanthropus* skull at Trinil. The following October the papers reported that it was a human skull filled with hard volcanic tufa. This was enough to arouse suspicions, and the first photograph gave the show away: it was not a calvarium, but an isolated spheroid joint from the upper foreleg of a giant elephant! What a disappointment after so many years of waiting!

Towards the end of 1928 the situation could be summed up as follows:

Did the skull-cap and the thigh-bone belong to the same species? As long as two separate species of hominid had not been demonstrated in the Trinil deposits the connexion of the two finds was to be assumed, since as a rule—we shall hear later of an exception—only one human species occurs at one level.

Reconstruction of the skull was a more difficult matter. The calvarium, as we have learned, was thick and corroded. On the right side, just at the broken edge, was a thick, slightly protruding piece of bone, which Dubois held to be the remains of an ear-bone. Hence his reconstruction made the skull an extremely low one. In 1928 the German anatomist Hans Weinert, after Dubois had allowed him to see his original material, challenged this interpretation and placed the ear-hole much lower down in the missing section, so that in his reconstruction the skull became higher and more human. Which of the two was right?

The skull's geological age posed a further difficult problem. Did *Pithecanthropus* live in the Pleistocene, or did he still belong to the Tertiary?

The Pleistocene corresponds to the Ice Age in the temperate zone and can be fixed by calculation, since Ice Ages are caused by astronomic events (periodic changes in the position of the earth's axis, eccentricity of its orbit). Four great minima, corresponding to the four glaciations, can be clearly established,

although not everybody is in agreement about the details; nor as to the full application of the 'radiation curve', worked out by the Yugoslav scholar Milankovitch. But we know that the Pleistocene began about 600,000 years ago and ended about 20,000 years ago.

Palaeontologically, the beginning of the Pleistocene (sometimes known as the Diluvium) is differentiated from the preceding period by the first appearance of horses and true elephants. The evolution of the horse took place in America, whence the animals immigrated over a land-bridge into Asia (in several waves) and rapidly spread across the whole of the Old World.

The Tertiary—we shall restrict ourselves to the later Pliocene and the earlier Miocene, both of which together form the Late Tertiary—was a more or less tropical period everywhere. Its age is such that it opens up completely different vistas. The beginning of the Pliocene lies some 10,000,000 years back, that of the Miocene 20–25,000,000 years. The fauna, and to a lesser degree the flora, differed substantially from that of today, and the older the strata the greater is the contrast. Virtually no mammalian species of the Pliocene is still living.

To find man's Tertiary forerunners had always been a palaeontologist's wish-dream. When Dubois issued his first description of the fossil Javanese fauna he designated it Pleistocene. But no sooner had he discovered his *Pithecanthropus* than the fauna had suddenly to become Tertiary. He did everything in his power to diminish the Pleistocene character of the fauna, writing:

> What chiefly characterizes the diluvial epoch are the great reductions in temperature that periodically made themselves felt all over the earth. Although during the Later Tertiary period the gradual zonal differentiation of climates was especially intensified, the climatic changes that took place towards its end were relatively much more sudden events which, in the middle and higher latitudes, through the extent to which they spread the ice

> in these colder zones, exercised the greatest influence on the transformation of the mammalian kingdom. . . . In Equatorial regions, on the other hand, these fluctuations of climate must have passed almost unnoticed; the character of the mammalian fauna cannot have been appreciably altered by them. . . . Accordingly, whereas in Europe and other regions in higher latitudes the diluvial fauna was at that time composed of a relatively large number of mammals now extinct, besides those which are still alive or had only temporarily immigrated from colder regions, the diluvial climatic changes in the tropical areas of the earth can scarcely have changed the mammalian kingdom in these regions.

The criterion was no longer to be the fauna as a whole, but only his *Pithecanthropus*. Such a primitive form belonged to the Tertiary!

Dubois's view, as we have seen, did not go uncontested. But there was no getting at him until he had described his whole collection and laid all his cards on the table. That was why we all had to wait for a study of his finds, and to wait in vain. The description of the Selenka collection explained a great deal to us, but not everything.

Thus the *Pithecanthropus* problem had, so to speak, a geological as well as an anthropological side. The question, "Was *Pithecanthropus* human?" was suddenly brought to the fore again—by new finds made, not in Java, but in China.

CHINA

MARCH 15—I am speaking now of the period before the Second World War—was always a special day for everyone who worked at the Anatomical Institute of the Rockefeller Medical Institute in Peking. On this day the staff—the few Europeans and the inscrutable, serious Chinese, with Li, the old draughtsman, and Chu, the skilful preparer, at their head—made their way together in a ramshackle car to the European Cemetery beside the western wall of the city. Here they laid a few flowers on the grave of the man whose creative imagination and perseverance, crowned by discoveries, had made his Institute at Peking a scientific centre of the first rank, and who had paid for his love of science with his life. The name of this scientist was Davidson Black and his discovery was Peking man.

The Dragons and Peking Man

WHAT WOULD CHINA BE without the dragon? There is not a roof, not an ornament, not a piece of embroidery, and scarcely a teacup in the Celestial Kingdom without one. The dragon family has many members: there is Lung, the dragon of the sky; Li, the dragon of the sea; Liao, the dragon of the mountains. The imperial dragon has five claws; that of princes and high officials only four; while the dragon of merchants has to be content with three. There are certainly enough dragons in China.

Did such creatures really exist? Yes, even if not quite in the shape depicted by the Oriental imagination. Dragon's teeth (*lung tse*) and dragon's bones (*lung ku*) can be obtained from every better-class apothecary's shop, providing one has the necessary prescription and sufficient money; for everything

originating from such a huge beast must be a powerful therapeutic agent, and for this reason alone is expensive. To an expert eye it is immediately evident, of course, that the so-called dragon's teeth are not those of reptiles, as would be expected, but of large mammals, well fossilized, such as are not infrequently found in the soil of certain districts in China. The horns of small deer are particularly common, and these horns are always portrayed as decorating the dragon's head.

Our earliest knowledge of the fossil mammals of China was due to such material from chemists' shops, which attracted the attention of British geologists as early as the 'seventies. The great geographer and China traveller Professor von Richthofen brought back a fairly large collection, and during the Boxer Rebellion of 1900 we see Dr Haberer at work making a collection for Professor von Zittel of Munich. Haberer was the first to collect systematically and pick up all the material he could wherever he went. His collection contains almost a hundred different species; but, although he came into possession of an enormous number of isolated teeth, he was able to obtain only a few fragments of jaw. The study of this material by the brilliant Professor Max Schlosser at Munich, in 1903, took us an appreciable step forward. Schlosser described numerous antelopes, giraffes, hyaenas, sabre-toothed tigers, elephants and primitive rhinoceroses. Particularly common in China are remains of a rhinoceros without a horn, the aceratherium. Many columnar teeth belong to *Hipparion richthofeni*, a three-toed horse the size of a pony. But the most interesting fossil was a worn upper molar originating, in all probability, from an ape-like man or a man-like ape. Schlosser could not make up his mind on this meagre evidence. The tooth had been bought in a Chinese apothecary's shop in Peking and was assumed to have come from the vicinity of the old imperial city. Thus our attention was directed at an early stage to North China. The remarkable tooth later mysteriously disappeared from the Munich collection.

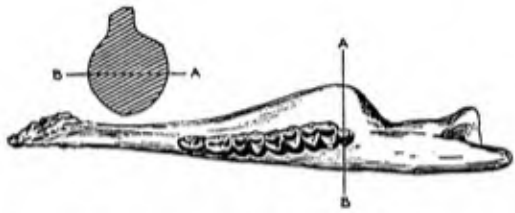
There were many Swedish missions working in China, and after the First World War people in Sweden began to take an interest in China's geology and palaeontology. The driving force was Gunnar Andersson, a Swede who had come to China as adviser to the Government on mining affairs. Andersson, who was really a geologist, did a great deal for the geology of China, but he was so impressed by the ancient Chinese culture that he later became an archaeologist. Today he is director of the Eastern Asiatic Collections in Stockholm.

Sweden put large sums of money at Andersson's disposal. The universities took a great interest in the project, so did the royal family, and not least the match-stick king, Ivar Kreuger, who committed suicide in Paris in 1932 in circumstances that were never explained. Kreuger was the real founder of China's important palaeontological journal *Palaeontologia Sinica*, in which henceforth all the discoveries of prehistoric life in China were to be published in exemplary fashion. Up to 1945 more than 125 volumes had appeared.

In spring 1918 Andersson had heard in Peking that there was a hill near Chou K'ou Tien—Chi Ku San, "Chicken Bone Hill"—where many small bones had been found that were obviously fossilized. He visited the site, and after the Austrian-born Dr O. Zdansky had been sent to China with Swedish support, excavations were begun there in 1921.

Just at this time a few American geologists were in Peking making preparations for the New York Natural History Museum's great expedition to Mongolia. One of the palaeontologists on this expedition was Dr Walter Granger, and Andersson invited him to visit his excavations on Chi Ku San. It seems that the presence of so many whites in this out-of-the-way spot had drawn a few rather more communicative Chinese to the site. In any case, the palaeontologists learnt on this visit that there was a better site on the other side of the village, where much larger teeth and bones were to be found. They set off together—and it was so! They found there not only the

bones and teeth of deer, but also some remarkable splinters of quartz that were really quite out of place in this limestone quarry and might perhaps have been brought there by men intending to use them as tools. "Here are the traces of fossil man; you have only to find him," said Andersson prophetically. Chou K'ou Tien was to prove one of the most important localities for finds of prehistoric man in Asia.



5 Strikingly thick lower jaw of a deer from Chou K'ou Tien, seen from above and in section

Zdansky immediately began digging at the new site. The material was packed and dispatched to Sweden, and Zdansky himself soon went back to Sweden. In October 1926 the Swedish Crown Prince came to Peking while on a world tour, and Andersson organized a scientific gathering. On this occasion he wrote a letter to Uppsala to find out how the study of the Chou K'ou Tien fauna was progressing. Zdansky gave him a detailed list: he had identified some twenty different mammals. Amongst them were horses, bears, hyaenas, sabre-toothed tigers, rhinoceros, buffalo and pig. One species of deer was notable for its strikingly thick lower jaw, whose section in extreme cases was almost circular. Most important and exciting of all, however, were two teeth of fossil man. Zdansky had already spotted one tooth at Chou K'ou Tien, the other had emerged in the course of preparation at Uppsala. Andersson was jubilant: "The man I predicted has been found," he wrote. Zdansky himself was very cautious, merely designating the

teeth as human, as "*Homo sp.*", without giving them a name of their own. But in Peking there was great enthusiasm, and old Professor Grabau, the father of Chinese palaeontology, spoke for the first time of "Peking man".

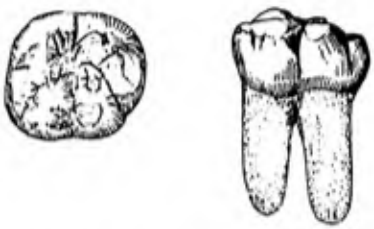
These discoveries made a deep impression on Dr Davidson Black, professor of anatomy at the Rockefeller Institute, Peking. Black was a Canadian who had studied at London and had an ardent interest in fossil man. He succeeded in drawing the attention of both the Rockefeller Foundation and the Geological Survey of China to the new discoveries in North China, and the Rockefeller Foundation gave money generously for the establishment of a large Institute that was called the Cenozoic Research Laboratory. The Cenozoic period, the modern era of geological history, comprises not only the Ice Age but also the whole of the Tertiary, the great epoch of warmth which preceded it and in which the development of the mammals (including man) took place. There was no intention of confining research to the oldest remains of man. All finds were to be studied in Peking and remain in China. This was a magnificent undertaking that was soon to bear rich fruit.

A young Swedish geologist, Dr B. Bohlin, now came to work in Peking. Digging was begun with a large labour force, and between April 16 and October 18, 1927, more than 3,000 cubic yards of earth were sifted. An enormous collection of bones was gathered, but to begin with there was no sign of man. Finally, on October 16, only three days before the excavations were due to end, Bohlin found a massive human lower molar. He immediately recognized the significance of the find and brought it personally to Peking. He handed his tooth to Black on October 19.

It was a remarkable tooth, very large and with a great many wrinkles. Black had never seen anything like it. He made a detailed comparison of this tooth with human and simian teeth and came to the conclusion that it was a relic of a hitherto

unknown fossil man, whom he designated *Sinanthropus pekinensis* BLACK & ZDANSKY. It was certainly audacious to label a new prehistoric man on the basis of this tooth. But Black felt fully justified in doing so.

Shortly afterwards Black went on leave to America and Europe. He had a large gold watch chain made for him in



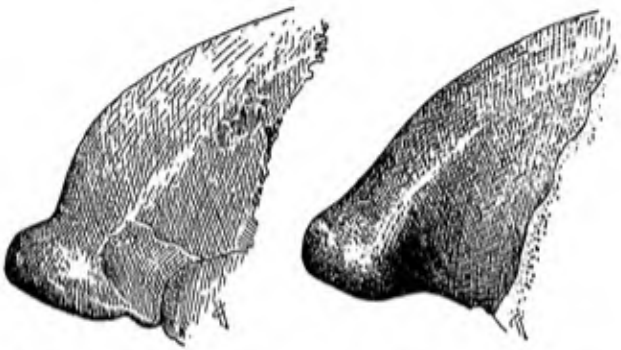
6 The human tooth found by Bohlin at Chou K'ou Tien on October 16, 1927, on the strength of which Black described and predicted Peking man as a new human species (about natural size, after Black)

Peking, with a small receptacle hanging from it, into which the tooth exactly fitted. In this way he travelled about the world with his precious fossil, showing it to colleagues and asking their opinion.

In Chou K'ou Tien the search continued feverishly. From 1927 to 1929 a total of sixty-four weeks were worked, 8,800 cubic yards of earth sifted, and 1,485 boxes full of fossils sent to Peking. Only a small quantity of additional human material came to light—isolated teeth and also fragments of lower jaws. The first skull was at last discovered at 4 p.m. on December 2, 1929. Dr Pei, a keen young Chinese, was the one to find it. The skull lay in a bed of hard limestone, and Black, who saw to its preparation personally, took four months simply to free it from the stone. It was a juvenile skull, strikingly thick, the

cranial sutures not yet closed. Black took the cranial bones apart and had each one cast separately, before fitting the skull together again as a whole. The limestone filling inside the cranium gave a clear natural interior cast.

The cranium was relatively small and low. It had virtually no forehead and a continuous, bony supra-orbital ridge, such



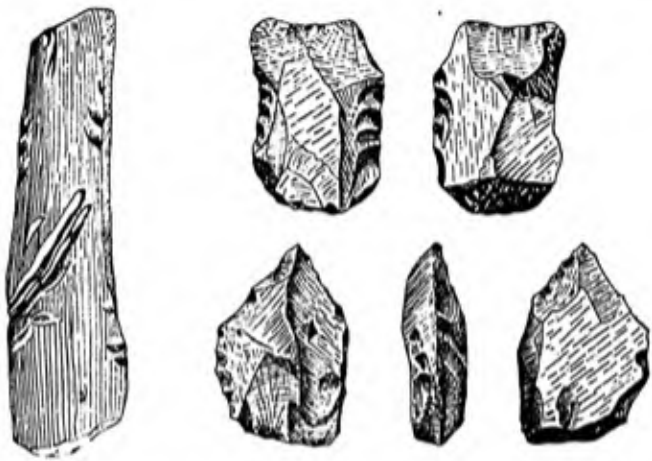
7 The frontal bone of Peking man (*left*) and *Pithecanthropus*

as we only see among anthropoid apes, projected sharply over the eyes. None the less, anatomically there could be no doubt that it belonged to a primitive man. Not only was the cranial capacity of about 1,000 c.cm. too large for an ape, but also the brain-cast clearly showed an approach to human proportions. Completely human, too, was the fossa of the temporo-maxillary joint, which was deep-cut as in modern man, not shallow as in apes.

But Peking man was not only anatomically human. The sharp splinters of quartz that had already struck Andersson proved indeed to be implements. Unfortunately quartz is a poor material that cannot be worked as easily and cleanly as flint, but enough pieces were found possessing the unmistakable

character of tools. Furthermore, the objects were discovered in a limestone area, and one has to go several miles farther north to find quartz. Only man could have gathered these sharp splinters of stone for use as implements.

One of the most astounding discoveries at Chou K'ou Tien



8 Fragment of bone from Chou K'ou Tien showing incisions made with stone instruments (*left*)

9 Stone implements of *Sinanthropus* from Chou K'ou Tien (after Black)

was the fact that this primitive man was already familiar with fire. Thick layers of ashes were found, and it was evident that these were hearths in which a fire must have burned for days, and probably weeks, on end.

His initial study of the skull was enough to show Black that the cranial curve of Peking man was exactly similar to that of the disputed Javanese *Pithecanthropus*. Since there could be no doubt that Peking man, despite all his primitive characteristics,

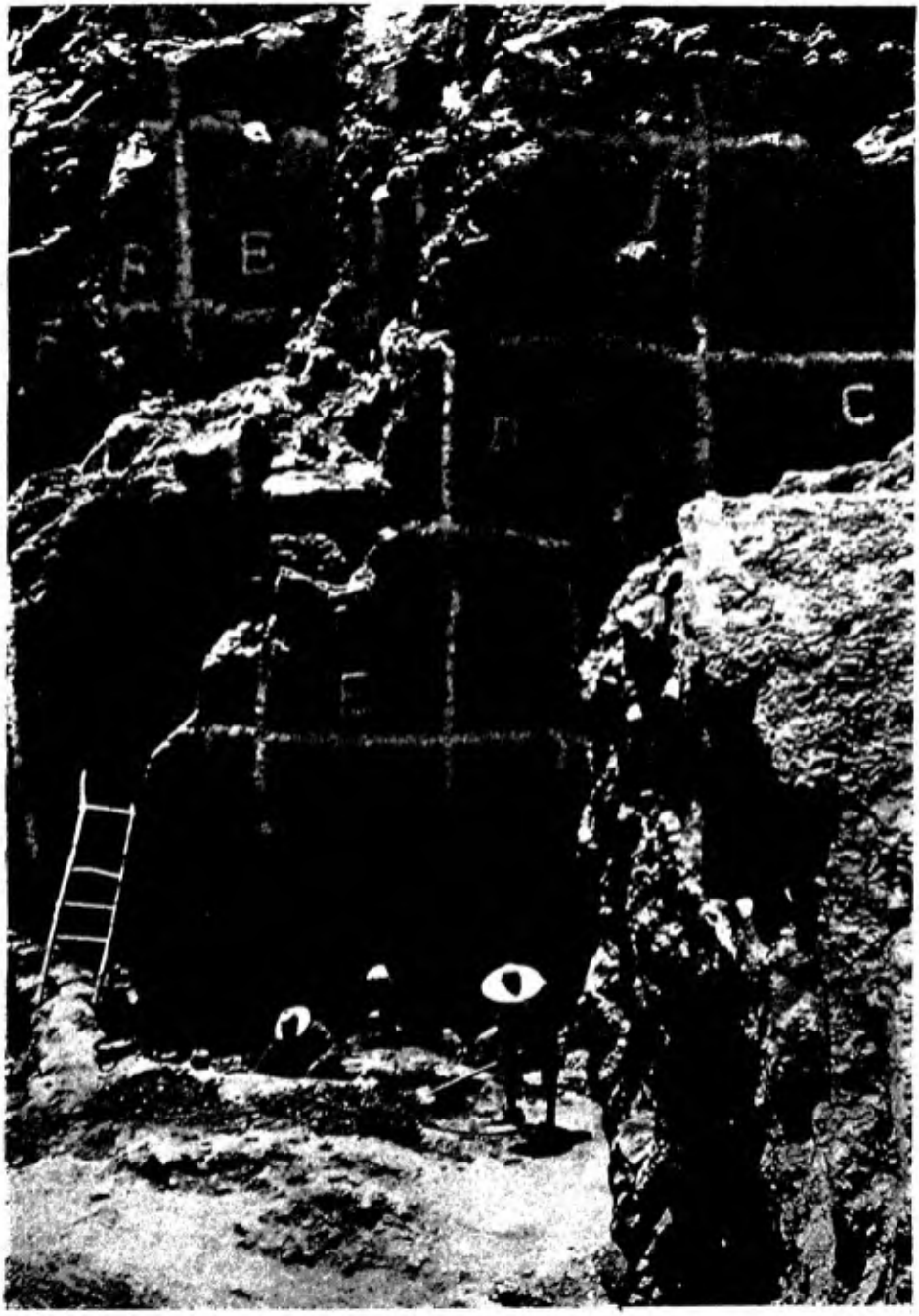
was genuinely human, practically all Dubois's opponents were convinced by this new find that *Pithecanthropus*, too, must have been human.

Black was fascinated by his discoveries and wanted to do everything himself. In order not to be disturbed, he did most of his work at night. He rose at noon, visited his friends, dined at the Peking Hotel in the evening, and around midnight vanished into the Institute. There he worked until early morning, and when his secretary appeared at 9 a.m. she found his manuscript and his notes on the desk.

Black's health was not robust and he really ought to have quit Peking because of its debilitating climate. But he did not want to leave until he had completed his study of Peking man. He tried to stick it out, but it was too much for him. When his secretary entered his room on March 15, 1934, she found him slumped over his desk, dead from a heart attack, with the beloved skull of Peking man in his hand.

His successor was Professor F. Weidenreich. Weidenreich had originally worked as a pupil of the great German anatomist Schwalbe at Strasbourg, and after the First World War had occupied chairs at the Universities of Heidelberg and Frankfurt. He went to America in 1933 to lecture, and subsequently did not return to Germany. His work on comparative morphology had made him very well known, and at an early stage he had concerned himself with Peking man. Now he went to Peking as Black's successor.

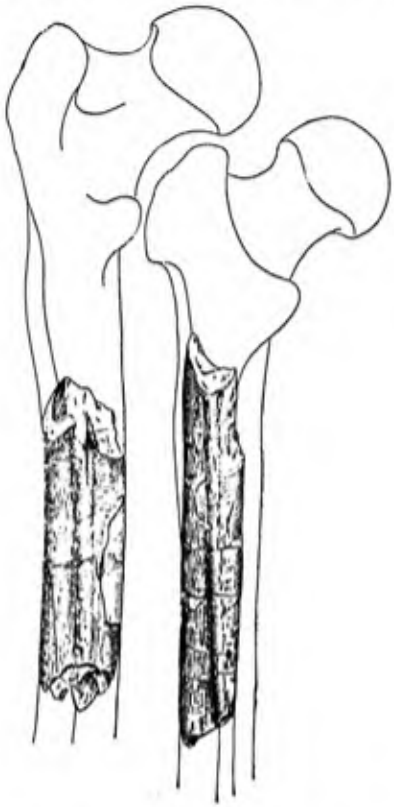
Meanwhile excavations had continued at Chou K'ou Tien. At the beginning, the site of the find had resembled a cave. It now proved to be a wide cleft, in which prehistoric man had sought shelter and which had slowly been filled up with debris from above. Stratum lay upon stratum, many of them full of bones and ashes, stone implements and jaws; others were sterile, indicating that at times the spot had remained uninhabited. A vast accumulation of bones showed that Peking man had been a skilful hunter. The quantity of refuse seems to have attracted



Chou K'ou Tien, where Peking man was found.
The 1937 excavation site

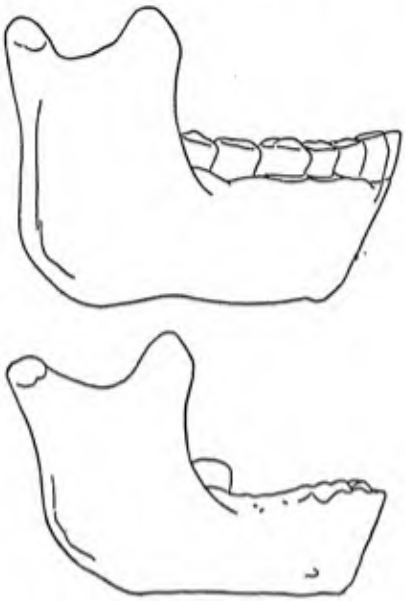
The reconstructed skull of Peking man. Note the powerful and clearly marked eyebrow ridge (after Weidenreich)

Skulls of Peking man (*left*) and modern man, seen from in front at the same angle (after Weidenreich)



10 The thigh-bones of Peking man found at Chou K'ou Tien are all severely damaged and often smashed into small pieces to extract the marrow. The damage was not the work of beasts of prey, but undoubtedly of humans (½ natural size, after Weidenreich)

a large number of hyaenas, and the remains of more than a thousand specimens were found here; relics of man were rare. Altogether, the scanty remains of some forty-five individuals were brought to light. The word "individual" is perhaps an



11 Mandibles of Peking man, reconstructed (½ natural size). The upper mandible belongs to a male, the lower to a female. The difference in size is so marked that they were thought at first to belong to two different human species (re-drawn after Weidenreich)

exaggeration, for many of them were represented by only a few teeth. The total yield amounted to about a dozen skulls and jaws, numerous teeth, but little from the rest of the skeleton. The material was sufficient to completely reconstruct at least the skull. All its parts are known with the exception of one—the region round the occipital foramen. For Peking man was found to have possessed one very human trait: he was a cannibal. All the skulls were smashed, the region round the occipital foramen was broken away in order to extract the

brain, and there was even a femur that had been split lengthways to get at the marrow.

The lower jaws are large and coarse, without a chin. Two types can be distinguished, so different in size that they were originally assumed to be derived from two different species of prehistoric man. The skulls themselves, however, are so uniform that this view was untenable. We are therefore compelled to assume that there was in Peking man a pronounced sexual dimorphism, i.e. that the females of this species were much smaller and more delicate than the males. In modern man we no longer encounter this in such an extreme form, but it is very characteristic of the anthropoid apes. In the gorilla the male is nearly twice the size of the female.

Our real knowledge of Peking man does not amount to very much. The skull is the best-known factor, and Weidenreich used it to have a rather excessively idealized reconstruction made by the American sculptress Lucille Swan, which came to be known in Peking as "Nelly". During the war, when those in Peking did not know what had happened to the *Sinanthropus* collection, someone wrote on a card to New York, "Where is Nelly?", and Professor Weidenreich, then working at the American Museum, immediately guessed the tragic fate that had unfortunately overtaken Peking man. Nelly looks out into the world from beneath a thick supra-orbital ridge, fresh, intelligent and unperturbed, as only a person can look who has never been to school. Nelly is a true "Daughter of the Evolution".

The cranial capacity of the *Sinanthropus* skull varies between 915 and 1,250 c.cm., with an average of about 1,050 c.cm.; in Europeans, women have an average of 1,350, men of 1,500 c.cm. The dentition is more massive than is general in modern man. The lower jaw is chinless, and the lower frontal premolar —the tooth behind the canine—is larger than in modern man. The crowns of the molars are strongly wrinkled, which gives them a marked character of their own. There has been

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much argument as to whether such complicated teeth could occur in a true progenitor of man, since our dentition had been regarded as primitive and original. As we shall see, this was a fallacy.

The incisors all have a protuberant edge, a type often described as "shovel-shaped". Such incisors are occasionally found among all races, but are most pronounced among the

12 Lower jaw of a hyaena from Chou K'ou Tien (after Black)

Mongols, where they may be regarded as a typical racial characteristic. For this reason, and also because of the occurrence of outgrowths on the edge of the jaw-bone and a few other peculiarities, Weidenreich pronounced *Sinanthropus* a forerunner of the Mongols. Few people have accepted his view, however. Until we can find evidence that the Neanderthaloids split up into groups corresponding to contemporary races—and of that there can be no question at present—this theory has insufficient foundation. There is no certainty as to the age of the present races of man: many investigators put it at between twenty and thirty thousand years.

To judge by the thigh-bones, Peking man was about 5 feet 2 inches tall in the case of the male, with the female some 5 inches less; he was therefore comparatively small. The

relation between upper arm and thigh is very striking. In chimpanzees the two are about the same length, whereas modern man's thigh is about 25 per cent longer than his upper arm. In the case of Peking man the difference was only about 20 per cent, so that on this point he occupies an intermediate position.

In the fauna we find numerous forms now extinct, although as a whole it would not strike us as very unfamiliar. Many of the species, such as the rhinoceros and hyaena, no longer occur in China. But there are few truly extinct forms. Of these the most important are the sabre-toothed tiger and the so-called trogontherium, a giant beaver, whose remains have also been found in Germany in association with Heidelberg man.

I myself was able to visit Chou K'ou Tien in 1937. Work was then proceeding at a depth of 110 feet. Chinese workmen were to be seen sitting everywhere in pairs, one digging and one sifting the material. The bones and teeth were set apart, the earth and lumps of limestone carried outside and dumped on the waste-heap. The cleft was found to be larger than originally supposed, and a small Chinese temple stood right on top of it. This was carefully demolished and rebuilt stone by stone at another spot. Whereafter a native artist decorated the interior of the temple with a Chinese version of the whole excavation.

By 1942 a depth of 170 feet had been reached without the excavators having come to the bottom of the cleft. A huge mass of material had been accumulated. Pei and Young had studied part of the mammals, and all the human remains were being investigated by Weidenreich. We owe to him a series of sizeable monographs in which the whole material is described in exemplary fashion.

Geological examination of the hill containing the site of the *Sinanthropus* finds disclosed a series of other clefts, some of them older than the actual scene of the excavation. Above all, a much more recent cave was found which likewise yielded a

large quantity of bones. Digging unearthed a few human skeletons, but they belonged to a modern type of man. There was, however, one remarkable find: three skeletons in a grave, a man and two women. The man's skull showed various primitive features no longer encountered in modern man. The women were particularly interesting: one of them showed typical Papuan features, while the other was of the American-Indian type. Her skull also showed signs of artificial deformation. It is the oldest find which shows deformation of this kind. Artificially deformed skulls can still be seen nowadays, e.g. in the Malay archipelago and in the South Seas; in the prehistoric field the ancient Peruvians are particularly noted for their tower-shaped heads. Similar deformations occurred in Europe until quite recently, especially in the neighbourhood of Lyons and on the little Dutch island of Marken. Such changes in the shape of the skull do not affect the intelligence. They are easily produced; the skull of the infant is merely forced into the desired shape during the first year of its life by wrapping cloths round it or binding a board to it. The earliest deformations are thought to have occurred in the Mongolian zone. The Mongols living in the steppes needed to strike their tents at frequent intervals and seek fresh pastures. The women had to assist in this, which left them no time to look after the young children. To keep them under control and protect them from injury during the journey, the children were bound to a plank, against which their heads were firmly pressed.

This so-called Upper Cave of Chou K'ou Tien also yielded fine bone needles of a type which in Europe is characteristic of the end of the Ice Age, suggesting that this site belongs to the same epoch. This would mean that the finds are about 25,000 years old. *Sinanthropus* himself might be approximately 300,000 years old.

It is tragic that the finds of Peking man did not survive the war. Last-minute efforts were made by the Americans to evacuate the unique material to the U.S.A. A major of the

American Marines undertook to bring the finds to America in his private luggage. But in December 1941, while the American forces were waiting on the Chinese coast for the troop-ship that was to take them home, war unexpectedly broke out. They were interned by the Japanese and lost all their equipment and baggage. Since then there has been no further trace of the finds. After the war attempts were made to locate some of the skulls, but in vain. On one occasion a notice appeared in the paper to the effect that one of the skulls had turned up in Shanghai, but it soon proved to be only a plaster cast. We must be grateful to Weidenreich for leaving such excellent descriptions of all the material. Indeed, I believe that many people who have admired the splendid drawings and photographs in his books would be disappointed if they saw the originals.

Sinanthropus is still the best-known example of man at the *Pithecanthropus* stage. Whether he actually represents an independent type is doubted by many anthropologists, some of whom go so far as to call Peking man simply *Pithecanthropus pekinensis*. The discovery of Peking man might have been expected to represent a great triumph for Dubois, who had up till then been exerting every ounce of his authority to convince the world that the disputed fossil was human. Curiously enough, this was not how Dubois saw it. Till the end of his life he refused to recognize any affinity between *Sinanthropus* and his *Pithecanthropus*. He described *Sinanthropus* as a degenerate Neanderthaler, and suddenly decided that his own find must be ascribed to a gibbon-like ape.

Thus, despite the discovery of Peking man, it remained necessary to find a further *Pithecanthropus* sufficiently complete to prove the human character of this disputed fossil.

The Tracks of the Giant

THE HABERER COLLECTION was well known to me from my student days in Munich, and when I came to Java in 1931 and saw how conservative the Chinese were I tried to go dragon-hunting in the Chinese apothecaries' shops. My first attempts were disappointing. I asked cautiously for animal teeth and all I got to see were the bones and teeth of tigers, stags' antlers,

13 Fossil spirifers from the Chinese Devonian, bought in Chinese chemists' shops in Java

and occasionally a rhinoceros horn. I had a strong feeling that the reserved Chinese were not showing me everything they had in their shops, and one day in Bandung I took with me a book containing many illustrations of fossils. It was a popular publication I had bought during my school-days, but I made out that it was a great medical work. The result was amazing. I showed them the illustrations of corals, and they came with corals, but modern ones. Instead of ammonites they brought me large snails, likewise modern; instead of trilobites, dried wood-lice. To my great surprise, when we came to the brachiopods they laid a whole collection of spirifers on the

table. The spirifers are a totally extinct group that occur with particular frequency in the Devonian formations. Almost all the examples belonged to *Spirifer verneuili*, a leading form of the Upper Devonian. Old Richthofen had already come across these spirifers in Chinese chemists' shops, and there can be no doubt that all the specimens came from China.

For us, the discovery of this type in the Javanese shop was an important event. Years ago a geological map of Celebes was drawn up, and no traces of Devonian strata were found on the island. Shortly afterwards the Geological Institute, Amsterdam, received from a naturalist on Celebes a good-sized collection of fossils, amongst them a few of these spirifers. A violent argument broke out as to whether these fossils really came from Celebes. If they did, it meant that all palaeographic deductions made hitherto were invalid. Then it transpired that these fossils had been imported from China. Later, we were able to buy the same fossils in a Chinese chemist's shop in Macassar on Celebes; the source of the disputed spirifers could thus be established without a shadow of doubt.

To return to the Chinese apothecaries. When I showed an illustration of fossilized crabs, a packet of genuine fossilized crabs was laid on the table, which enabled us once again to rectify a mistake in the literature on the subject. In his great work on petrifacts Quenstedt had illustrated exactly the same crab, giving Surabaya Harbour as its place of origin. Once more it was clearly an imported fossil.

The great surprise came when I showed the illustrations of fossil teeth. Our Chinese gave a friendly nod, disappeared, and returned with a great rhinoceros tooth. The specimen was badly damaged and chipped all over. Little pieces had been knocked off for use as medicine, and also the great pulp cavity had been intentionally hollowed out and filled with some glistening calcareous crystals. Smiling politely, the apothecary explained to me that this was not the tooth of an animal, but of a dragon, and that I should ask not for animals' but for dragons' teeth.

He gave me a prescription, and henceforth I got what I wanted in every chemist's shop.

My first year in Java brought a rich yield of teeth from the Chinese Pliocene deposits. The climate in Asia and Europe changed radically some ten million years ago. This was due to the thrusting up of great chains of mountains, such as the Alps, the Carpathians, the Caucasus, the Himalayas, and the mountains of Central Asia. Over wide areas the climate became drier, the jungle vanished, resulting in a savanna such as now exists in East Africa. The emergence of broad stretches of grassland caused antelopes and giraffes to develop a number of extreme forms. There was a sharp contrast between dry and rainy seasons. During the dry season the animals congregated in thousands at the drinking-places, and when even these dried up they died in vast numbers. During the next rainy season the carcasses were swept together by the waters, producing gigantic deposits of bones. Rich "bone beds" are particularly characteristic of the Pliocene; hence we know the Pliocene fauna far better than that of any other Tertiary formation. It seems that the Chinese discovered bone deposits of this kind a long time ago, and that the teeth of the three-toed horse, the hipparion, were a particularly popular article of trade. In certain chemists' shops we found hundreds of hipparion teeth and almost no other material.

The fauna from these hipparion levels is best compared with the contemporary African fauna: an immense number of antelopes, giraffes and hipparions (roughly corresponding to the zebra), together with great cats, hyaenas and many small beasts of prey. The hyaenas are especially interesting, for these evolved from civet-cats, and in the hipparion strata we find all transitions from the ictiterium, which still resembles the civet-cat, to a hyaena not essentially different from the modern form. Pigs play only a subordinate role, so do deer. Large numbers of the most various types of rhinoceros occur, of which the hornless aceratherium has already been mentioned.

A giant representative of the rhinoceroses was the rare sinotherium, which had a horn on its forehead and whose last representative, the elasmotherium, did not die out until the Ice Age. Fossil man probably knew it, and we may guess that it was the original unicorn.

When I began my studies of Chinese fossils, the times were no longer so prosperous, and even the Chinese were not earning as much as before. This gradually showed in the chemists' shops. The material of the hipparion fauna is excellently fossilized and heavy; these are "prime quality dragons' teeth". Gradually an increasing number of less thoroughly fossilized material came on the market; it was lighter in colour, weighed less, and clearly represented an inferior quality of the medicine sought. In the hipparion strata it had been quite a common occurrence to find whole skulls and jaws; it was evident, too, that the teeth had been forcibly knocked out, since they fetched far better prices than the bones. But the new material consisted exclusively of teeth or of crowns of teeth. Everything in the nature of bone had been gnawed away by porcupines, leaving only the crowns. The difference lay not only in the state of preservation, however, but in the whole fauna. Horses' teeth did not occur at all; instead, there were any number of porcupines' teeth, which were entirely alien to the hipparion fauna. It soon proved that the two fauna, species for species, were different.

Amongst the commoner fossils were the high lamellae of elephants and the molars of tapirs and Malay bears. One day I was given a fragment of a big, wrinkled tooth that reminded me very much of an ape's tooth. After much inquiry we learned that it belonged to the great panda, the bamboo bear, which still occurs in remote districts of China and may now and then be seen as a great rarity in zoological gardens.

At the beginning of 1935 we had a congress at Manila, and rummaging through the Chinese apothecaries' shops I came across considerable numbers of "second-class dragons' teeth".

To my amazement there were a few large, finely wrinkled teeth amongst them, which undoubtedly originated from an extinct orang-utan. Overjoyed, I made straight for the club, where I had an appointment with Professor Shellshear, and proudly told him of my discovery. Shellshear only smiled and drew from his pocket a letter he had received that very morning. In this letter, which had been forwarded to him from Hong Kong, our friend Teilhard de Chardin told him that he had just finished a geological tour through South China, the most important result of which had been the discovery of a fossil orang-utan. The teeth likewise came from an apothecary. So we had both made the same discovery independently and simultaneously. Immediately after the conclusion of the congress I went to Hong Kong, and with the help of a Chinese assistant I managed to pick up several hundred orang-utan teeth in the chemists' shops. After all this there could be no doubt that the orang-utan, which is today confined to Borneo and Sumatra, was originally a native of China as well.

These finds had cast a first ray of light on the prehistory of one of the great anthropoid apes. Strange as it may sound, we are unacquainted with the progenitor of either the gorilla or the chimpanzee. Because of the highly evolved elephants represented here, the age of the geological strata from which these teeth in the Chinese apothecaries' shops originated must be estimated at around 300,000 years. Together with the orang-utan other animals existed in China that are today typical of Malaysia, such as the little long-armed gibbon, the Malay bear and the primitive tapir. This originally Chinese fauna must have been forced south by some shift in the climate, and it is reasonable to attribute this to one of the Ice Ages. The discovery of this chemist's shop fauna, which we called the Sino-Malayan fauna because of its Malayan elements, brought a new problem to the fore, namely the route by which these creatures entered the Malay archipelago. There are two possibilities: either they migrated from South China via Indo-China to Malacca,

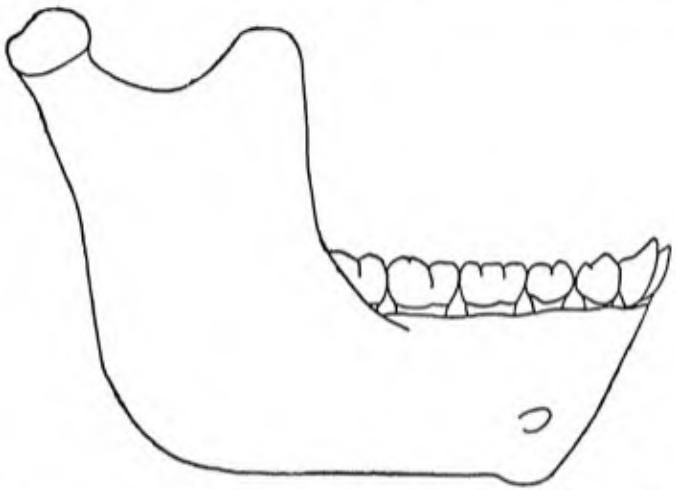
advancing from there across land-bridges to the Sunda archipelago; or a more direct link existed from South China via Formosa to the Philippines and from there via Borneo to Java and Sumatra. Unfortunately, extremely little is known about the fossil mammals of Formosa and the Philippines, but the frequency of the orang-utan in Borneo has always suggested to me that the second route is the most likely one.

Among the orang-utan teeth, of which we purchased more than a thousand from Chinese chemists' shops in the course of the years, were many strikingly large specimens—larger even than those of a gorilla. According to the general law of palaeontological evolution the most specialized forms are normally the largest. Of living anthropoid apes the orang-utan is certainly the most specialized, but the gorilla is far larger. From the finds in China it seems more than likely that the prehistoric Chinese orang-utan was larger than its descendants now living in Indonesia.

A few teeth from the chemists' shops of Hong Kong and Canton can undoubtedly be attributed to fossil man. For a long time the material was so meagre that it could only be assumed to belong to a variety of Peking man. At last—in 1939—we found in Hong Kong a first lower premolar far larger than that of modern man. Now, these large molars are characteristic of Peking man, so I was proved right in my assumption. Since these teeth were somewhat coarser than those of *Sinanthropus pekinensis* and did not possess the fine wrinkles that distinguish the latter, this new species was named *Sinanthropus officinalis*, "Peking man from the apothecary's shop". This find proved that, as might have been expected, *Sinanthropus* was once widely distributed throughout Asia.

Amongst the very first series of apes' teeth we bought in Hong Kong was a last lower molar that was far larger than any orang-utan tooth and clearly distinguished from the latter by a much coarser crown-relief. The tooth was also larger than the corresponding gorilla's tooth and must have belonged to

a giant Primate. Unfortunately, it was very much worn down. I described it as *Gigantopithecus blacki*, "Black's giant ape". I gave him the name *blacki*, of course, in honour of Davidson Black, who had discovered Peking man. Friends to whom I showed the tooth were unwilling to believe me, thinking it



14 Reconstruction of the mandible of *Gigantopithecus blacki* ($\frac{1}{2}$ natural size)

must originate from a pig or bear; but a detailed analysis of the crown elements showed that the tooth could only have come from a giant ape.

After the first discovery of orang-utan teeth in Chinese chemists' shops, I missed no opportunity of looking for teeth in such shops both inside and outside China. They were enormously widespread in the East. We found them all over Indonesia, in the Philippines, Singapore, Malacca, Siam and Indo-China. Even in San Francisco's Chinatown we found hipparion's teeth, and it was the same in Mott Street, New York. The Chinese often pretended not to have any teeth in

stock, since they knew only too well that, as a European, I did not believe in their magic efficacy. But when they saw my prescription they gave me a friendly smile, and always managed to find a little packet of carefully wrapped dragons' teeth in some corner or other. It was principally the "prime quality dragons' teeth" that were so widely distributed; most of my orang-utan teeth were found in the Indonesian area, i.e. in the shops mainly supplied from Hong Kong. Shanghai and Peking seem to be the sources of hipparion teeth.

Human teeth appeared in many chemists' shops, but they undoubtedly belonged to "modern" man and may have come from prehistoric burial-places in caves. Among these "modern" teeth were several that tallied exactly with the mysterious tooth Haberer picked up in Peking. Thus the tooth to which we all owed so much inspiration did not belong to Peking man at all (as Weidenreich had been inclined to suppose), but more likely to a Stone Age inhabitant of the "modern" type.

I always feel a peculiar sensation when the dragon's teeth are spread out before me in a Chinese apothecary's shop, and I look to see whether there may be teeth of a new, hitherto unknown species among them. In the course of the years the first *Gigantopithecus* has been joined by three others, just as large and coarsely wrinkled as the first. Two of these teeth are scarcely worn and bear an astonishing resemblance to human teeth. Professor Weidenreich, to whom I had sent plaster casts of these teeth and who described them during the war, sees in *Gigantopithecus* a giant man. This view has not passed uncontested, but as long as no remains of jaw-bone are available there can be no certainty. An upper canine in my collection probably also belongs to this giant form. It has a very strong, completely straight root. In anthropoid apes the root of the canine is always markedly curved, because of the formation of the muzzle, and the tooth tapers to a point. This canine would fit much better into a human face than an ape's muzzle.

Even if the *Gigantopithecus* were a giant man—one German

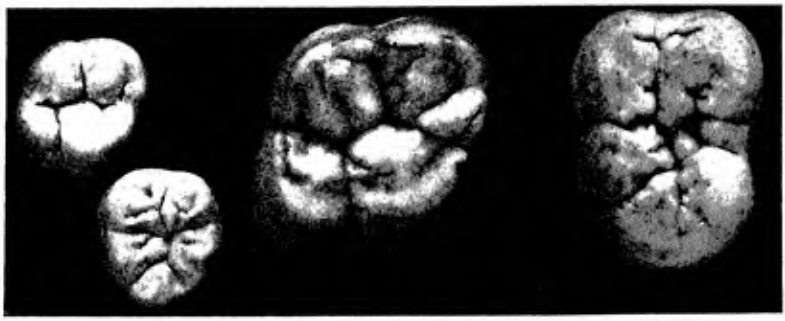
anthropologist wants to change the name from *Gigantopithecus* to *Giganthropus*, which is not, however, admissible under the rules of international nomenclature—he would still not have had any direct connexion with our family tree. As we have already seen, the same levels have yielded a true man, who is much more likely to have been a progenitor of modern man than his giant cousin. In addition, close study has revealed that the large teeth show signs of over-specialization such as a genuine forerunner of man cannot possibly have exhibited. We must assume that *Gigantopithecus* belonged to a collateral line and probably represented the end-form of the branch.

That the huge teeth of *Gigantopithecus* must have been embedded in prodigious jaws is immediately evident. Does this mean that *Gigantopithecus* was necessarily a giant? Some say that this does not automatically follow; on the other hand, all extant Primates exhibit an harmonious relationship between size of dentition and body size, and for this reason it seems extremely probable that we are dealing here with a giant form.

The riddle of *Gigantopithecus* still remains to be solved.

Pasar Glodok in old Djakarta; the centre of Chinese chemists in Indonesia

A collection of "dragonteeth", second-rate quality, from a Chinese chemist in Hongkong. To the right the prescription



Two teeth of the mysterious *Gigantopithecus*, obtained from Chinese drugstores in Hongkong, compared with the same teeth of modern man on the left (1½ times natural size)

The Chinese dragon bears the antlers of an extinct deer. Detail from the "Nine-Dragons Screen" in Peking

JAVA II

The Head-hunters of Ngandong

IN 1930 THE ONLY geological map of Java was one that was very out of date and known to be inaccurate in many respects. For some years the Geological Survey at Bandung, the beautiful city of villas in West Java, had been preparing a new map, and we palaeontologists had the job of comparing the sites of the various finds and fitting them into an over-all pattern, with the aid of the fossils discovered by the geologists. There were three of us: Dr Tan Sin Hok, a Java-born Chinese, who was primarily concerned with the foraminifers, a group of protozoa whose shells are so important for the part they play in forming deep-sea oozes; then there was Dr C. H. Oostingh, who very successfully described the numerous shell-fish and snails; and finally myself. My task was to establish the distribution of Java's recent land and river deposits with the aid of the copious mammalian remains.

Fossil mammalian remains are by no means rare at many sites in Java. These accumulations are generally due to sudden volcanic eruptions. Bones and teeth are particularly common in Java's most recent strata.

The formations of most interest to us here are the Pleistocene. It had previously been supposed that all recent folded strata in Java were to be assigned to the Tertiary, and that only the Pleistocene still lay horizontally. This soon proved to be a gross fallacy.

Geologically, Java's history can be readily reconstructed. In the Early Tertiary there seems already to have been land in the region of Borneo that was somehow connected with Asia. Java itself lay beneath the sea until towards the end of the Tertiary. Probably some large volcanoes formed a chain of

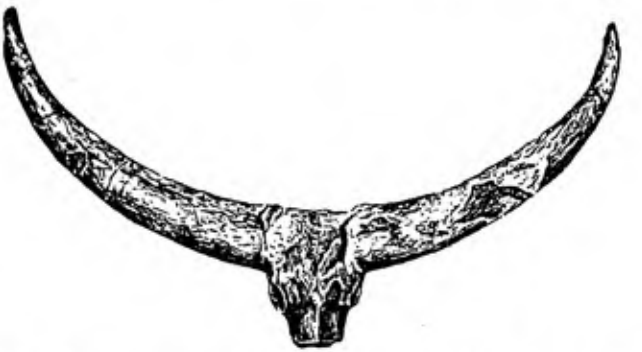
islands; a larger land mass did not form until the Middle Pleistocene, a period roughly 5 million years ago. The great Sunda islands—Java, Borneo and Sumatra—all lie on a submarine plateau, and a drop in the sea-level of only 130 feet would be enough to link this whole area with Asia. It is therefore not surprising that at times land-bridges existed, across which the fauna could enter our area. The first inhabitants seem to have been rhinoceros, primitive elephant and hippopotamus, such as have also been found in India. We called this first invasion the Siwa-Malayan after the Siwalik fauna at the foot of the Himalayas, which was already well known in the forties of last century. Now, this Siwalik fauna lacks all the elements that are nowadays typical of Malaysia: the orang-utan, the gibbon, the Malay bear and the tapir. We have already made the acquaintance of this community of beasts in China's chemist-shop fauna: it corresponds to a later immigration. The sea first becomes deeper to the east of Java and Borneo. Java, zoo-geographically speaking, is the south-east corner of Asia.

When we began our work, many sites at which fossil mammals had been found were already known. But more or less the same fauna cropped up everywhere: primitive elephants and hippopotamuses, many deer and pigs, bovines and antelopes. The only better known fauna was that of Trinil, which had been collected and described by the Selenka expedition and which we knew all came from one level. The awkward thing was that the Trinil site consisted of one stratum only, and we did not know what fauna was to be expected above or below it.

While we were still busy arranging the Trinil fauna in chronological order, ter Haar had the great good fortune to discover Ngandong. Ter Haar was an amiable colleague, tall, thin and always good-humoured despite his seven children. On behalf of the Geological Survey, he was occupied in drawing up a geological map of the Kendeng Hills, which are built

up of limestone, heavily folded and jumbled. It was not easy to sort things out here.

By the middle of 1931 ter Haar had almost completely surveyed the area west of the River Solo. He had set up his fixed quarters at Ngandong, a little *kampong* on the Solo where a timber-storage depot stood in the otherwise uninhabited region. One day he came home rather earlier than usual,



15 Skull of a giant water-buffalo from Ngandong. Span between the nucleus of the horns 7 feet

refreshed himself with a bath, and sat down on the bank of the Solo to watch the sunset. As a geologist he was accustomed to take note of stones, and he suddenly observed a layer of gravel and sand about 60 feet above the present bed of the Solo, which must have been deposited by the river while it was still flowing at this level. Poking about in this remnant of a terrace he came upon a pointed bone, and as he tried to prise it out with his hammer he discovered that he had had the luck to stumble on an almost perfect, large buffalo skull. The next day he had the spot dug over by several coolies and obtained from it not only his buffalo skull but also several bones and stags' horns. Obviously, there must be a fairly large bone bed here.

The old river terrace ter Haar had found had actually been discovered before him. Ngandong lies only some 6 miles north of Trinil in the transverse valley of the Solo, and Elbert, the Selenka expedition's geologist, had explored the land round about the old site and come upon the terraces. But since, at any rate in Holland, he was considered a man of excessive imagination, no one would believe him; the fossils he had collected there were not described until later. Now he had been proved right. Ter Haar himself made out three different sets of terraces—the first about 6 feet above the river-bed, the second about 20 feet, and the third almost 60 feet. This uppermost terrace at Ngandong yielded the bones and teeth. At many points the heavy tropical rain had washed away the sand and gravel from the terraces, and at Ngandong, too, there were only a few limited sites left.

The Geological Survey immediately began to take an interest in these terraces. Ter Haar discovered the Ngandong site on August 27, 1931, and Mantri Samsi began excavations in September. A *mantri* is an Indonesian who has received special training and can work on his own. The Geological Survey employs a considerable number of such geologically trained *mantris*, and their often self-sacrificing and altruistic aid was frequently of great value to the map-making geologist, who could not go everywhere himself in such a wide area nor stand beside every excavation.

Digging was begun at the precise spot where ter Haar had made his discovery. A trench was cut, and the bones and skulls carefully taken from the layer of gravel or sand. The deeper levels consisted of sand and gravel, and above these was a stratum consisting primarily of fragments of rock from the surrounding area. The whole deposit was about 10 feet thick but the bones lay in the bottom 2 feet. The finds were first dried in the shade and then wrapped in thin, tough Chinese paper that had been impregnated with size, numbered, and entered in a register with the date and level. Wrapping the

objects in Chinese paper—plaster of Paris is used for this purpose at many excavations in Europe—which was carefully removed in the laboratory at Bandung, helped to hold all the fragments together; for it is not always possible to avoid damage and breakages, especially of the larger finds, during transport. The material was then packed into large boxes on the site and carried through the jungle by coolies to Ngawi; there a car took it to the railway station, whence it went by rail to Bandung.

The director of the Geological Survey for Java, the engineer W. F. F. Oppenoorth, seemed from the outset to expect something special from the new site. With the help of a few *mantris* he personally unpacked the boxes, and we hardly saw anything of the finds. Buffalo skulls, a magnificent banteng skull with firmly attached mandibles, well-preserved stegodon jaws—to begin with that was all. But one day the rumour went round that human skulls had been unearthed at Ngandong and "discovered" during unpacking in Bandung. The first skull had come to light on September 15—only three days after digging began—as the twenty-ninth find to come up out of the trench. It was the major portion of a brain-case. A second fragment of skull had been found shortly afterwards, on September 30. Our *mantris* did not know what to make of these remarkable finds. The first had been entered in the register as a tiger's skull, the second—they had almost guessed it—as an ape's skull.

Oppenoorth immediately went to Ngandong. Skull-fragment III had just been found, and he brought it back to Bandung himself. These three fragments of skull formed the basis for a preliminary description in which this primitive man received the name *Homo "Javanthropus" soloensis*.

I myself had the honour of photographing the crania for publication. The first glance was enough to show me that—unfortunately—this was no new *Pithecanthropus*. The skulls were too lofty and too strongly vaulted, and the supra-orbital ridge

—though massive and well developed—projected less sharply from the cranium. In spite of its new name, Solo man proved to be a Javanese Neanderthaler.

But it was nevertheless a great discovery. There was no record of Neanderthaloid remains from Eastern Asia, with the exception of a single tooth in the loess of the Ordos Desert of South China. Our find proved the world-wide distribution of this form of primitive man, who is, so to speak, only a step away from ourselves, and our direct precursor. He owes his name to the idyllic Neanderthal near Düsseldorf. A small, almost inaccessible cave was encountered there during stone-quarrying in 1856, and a whole human skeleton came to light in the cave-filling. Most of this skeleton was lost through the carelessness of the workmen. All that remained were the skull-cap with huge eyebrow ridges, the two curved thigh-bones and part of the arm skeleton, a few ribs and a large fragment of the pelvis.

Fuhlrott, an Elberfeld teacher, who came into possession of the find and immediately diagnosed it as human, took it to Professor Schaafhausen at Bonn—an anthropologist who was far ahead of his time. Schaafhausen surmised that the skeleton in the Neanderthal was a primitive forerunner of modern man, but although he exerted all his scientific authority in support of the find, people were not willing to believe him and Fuhlrott. Rudolf Virchow, the anthropologist and prehistorian at Berlin University, opposed it, and oddly enough the majority of German scientists supported him. Virchow declared the skeleton to be that of a pathological representative of modern man, and even went so far as to ascribe it to a Cossack who had perished in the Neanderthal in 1814. And since the skeleton was found without accompanying fauna, nothing could be said about its geological age. Not until 1885, when two skulls of the same type were exhumed at Spy, not far from Namur in Belgium—this time in association with the remains of cave bear, mammoth and woolly rhinoceros—did it become clear to

everyone that this was an independent human type dating from the Ice Age.

Since then many further Neanderthalers—known scientifically as *Homo neanderthalensis*—have been found. Nowadays we know that it would be more accurate to speak of a Neanderthaloid group or a Neanderthaloid stage. The most recent representatives of this group—and they include the classical specimen from the Neanderthal—lived in Europe during the height of the last glaciation about a hundred thousand years ago.

This "cold Neanderthaler" is not the progenitor of modern man. His position among the Neanderthaloids is much the same as that of the Eskimo among modern men. He was a form adapted to extreme conditions of life. But from somewhat earlier levels, such as those of the warm period before the last Ice Age, we know a "warm Neanderthaler", whose skull is shorter and higher and who possesses less strongly marked supra-orbital ridges. To this group belong the German finds at Ehringsdorf near Weimar, and at Steinheim in Württemberg. This type is easily transformed into a primitive man of the modern stamp, i.e. *Homo sapiens*, through the Neanderthaloid features becoming less pronounced. This transition probably took place before the last Ice Age, for excavation on Mount Carmel in Palestine brought to light a Palaeolithic population in which *sapiens* and *neanderthalensis* characteristics are so mixed that it must represent a hybrid race.

Traces of the Neanderthaler have been found in Africa, not only in the coastal region on the Mediterranean but also in areas much farther south. A remarkably coarse skull, whose very large and elongated face gives it a positively bestial appearance, came to light in a zinc mine in Broken Hill, Rhodesia, in 1921, and remained for a long time unique. Not until 1953 was a similar skull unearthed in Pleistocene deposits under recently formed dunes at Hopefield, north of Capetown. And of all Neanderthaloids it is these two African skulls, and

particularly that from Hopefield, which most closely resemble our Javanese Solo man. They are all distinguished by a characteristic flattening of the lower surface of the occiput, which can only have served for the attachment of exceptionally powerful neck muscles.

The Solo skulls did not stop at three. Skull IV was found on January 25, 1932, and sent to Bandung; Skull V was found on March 17, and is one of the most impressive of the whole series. It is 22.1 cm. long, which makes it one of the longest, if not the longest, skull of fossil man yet known. In spite of its imposing length the cranial capacity cannot have exceeded about 1,250 c.cm.—Skull I has only about 1,000 c.cm.—since the cranial bones are more than 1 cm. thick. Despite its solidity, this particular skull had been smashed, and by a mighty blow with a blunt instrument—perhaps a large wooden club. The back of the skull had been severely fractured and a triangular fragment of the cranial wall, about 2 cm. long, had been pressed approximately 0.5 cm. into the skull. The area round these fractures had been blackened during the fossilization process, probably by the action of manganese, while all other parts of the skull were dark brown. Our Javanese, who prepared the skull at Bandung, were firmly convinced that the black colour was due to fossilized blood, and could not be persuaded to the contrary. Unfortunately, on orders from above, the skull was entirely taken apart during preparation and put together in its original shape, so that the fragment of bone that had been knocked in is no longer recognizable as such.

Yet another skull was found on June 13, 1932. This time, as soon as it was realized that it must be a human fossil, digging at this spot was stopped and an express letter sent to Bandung. Thereupon ter Haar was dispatched to the site—and I with him! It was my first trip to Central Java.

We set out by fast train on June 18, alighting at Paron, a little station between Surakarta and Madiun. The locality was extremely rural; as there were no cars we chartered two small

two-wheeled, horse-drawn carts, one for our luggage, the other for our own persons. After a good half-hour's journey we were glad to reach Ngawi. Our arrival had already been announced, and our *mantri* stood ready with a few coolies to carry our luggage to Ngandong. We ourselves followed on foot, for the path had grown so narrow that it was impossible to proceed farther by vehicle.

For two hours we walked through the spreading forest of the Kendeng. The Javanese is dependent on his rice-fields, which he can plant only where there is sufficient water. This is not available in the Kendeng, and so this zone—in spite of Central Java's overpopulation—is virtually uninhabited. Only on the banks of the River Solo are there a few *kampongs*. The Kendeng itself is planted with teak forest, whose gigantic leaves —while they certainly provide shade—make it almost impossible, once they have fallen, for the geologist to see anything of the ground. In the forests themselves the only human beings are occasional communities of Kalangs, who grub up patches of the forest and plant a few vegetables. The Kalangs are a curious Javanese ethnic group, about whom little or nothing is yet known. They are shy, live in the jungle, and claim that one of their forebears (they argue about whether it was the father or the mother) was a dog. We know similar stories from Borneo. The Javanese maliciously assert that the Kalangs have tails like monkeys and for this reason hide in the jungle. But the Kalangs are highly esteemed throughout Central Java as carpenters. On our way through the forest we were lucky enough to pass a few Kalang huts. I examined the people closely, but could see no outward difference between them and the Javanese, although they must belong to an originally older ethnic group.

A little later we reached the banks of the Solo. The river is still very deep at this point, and there were even crocodiles in this lonely region until quite recently. Our Javanese also told us of evil spirits. Here on the banks of the River Solo, they

told us, lives one of these who seeks to seduce the young boatmen who sail past. It shows itself in the late afternoon in the shape of a beautiful maiden bathing, but she is only beautiful from in front, for she has no spine and is completely hollow at the back. Woe to the young man who falls into her clutches. She seems to play much the same part in this district as the Lorelei on the Rhine.

We must have walked a good two hours before we reached Ngandong. The *kampong* consists of a very few houses, and the only person who actually lives here is a *mantri* in the Forestry Service who sees to the cartage of timber. Our excavation site lay a few hundred yards from the houses. Our workmen had dug a pit 10 feet deep, the floor of which consisted of marly rock—a sign that the terrace gravel went down no deeper. One gravel bank had been only half dug away, and a few palm fronds stuck in the sand marked the spot where the skull lay buried. We removed the fronds and ter Haar began to dig carefully with his hands, while I took photographs. Unfortunately, I was so excited that most of the shots were underexposed. After only a few minutes we came upon a large round object: this must be the skull. It proved to be the underside of a human skull; the cranium itself was still embedded in the gravel. In the case of every previous skull the underside had been in fragments; here at last it was intact. The foramen magnum was undamaged, but the place where the cranium had been knocked in was rather more to the front. In spite of a prolonged search we could find no trace of the facial section or the jaws. The skull itself was in an excellent state of preservation and undoubtedly the most perfect specimen discovered at Ngandong. We cleaned it as well as we could on the site and packed it carefully, for the final preparation could only be carried out at Bandung.

This was the first skull at whose disinterment I had personally assisted. In September of the same year I was again at Ngandong; this time we found the two parietal bones of Skull VIII;

and in November, when I visited the site for the last time, I was able to bring back Skull XI. This was shortly before digging at this spot came to an end. We had shifted by far the greater part of the terrace, leaving only a small pillar standing to enable future geologists to check our statements.

In all, therefore, we had found no less than eleven cranial remains of Solo man. Of the skeleton only two shin-bones (which, incidentally, did not differ in any way from those of modern man) had come to light; there were no lower jaws, no teeth, no vertebrae or other bones. At the same time we had unearthed no less than 25,000 bones and teeth of various animals. Although we had not found any complete skeletons, we had occasionally come across a piece of the spinal column with connected vertebrae or a skull with a lower jaw firmly attached. A vast number of different bones of all the animal types were unearthed, but of human remains only a very particular selection whose incidence was certainly not natural. Looking at the skull finds as a whole it becomes evident what must have happened here. In all the skulls but two the region of the foramen magnum is completely smashed, a phenomenon we have already seen in Peking man. If we examine the skull trophies of modern head-hunters, we find that here, too, the region of the foramen magnum is severely damaged. The head-hunter is not content merely to possess the skull, but opens it and takes out the brain, which he eats in order by this means to acquire the wisdom and skill of the defeated foe. What we had found at Ngandong, therefore, were skull trophies. The huge accumulation of animal bones suggested that we were dealing with a resting-place of primitive men, strategically situated on a loop of the river. Here not only could they lie in wait for the animals that came to the river to drink, but they were also to some extent—though obviously not completely—safe from attacks by other members of their race. From the strata of sand and gravel we assumed that primitive men camped here mainly in the dry season and that the refuse

they left behind was covered over with sand and gravel during the floods. The human skulls must have been left behind, either intentionally or unintentionally. Perhaps the horde was taken by surprise and fled: perhaps the skulls were put down to mark off the area. It seems that even today various tribes in New Guinea demarcate their dwelling- or hunting-grounds in a similar manner. They evidently suppose that the spirit dwelling in the skull can help them to defend a particular area against invaders.

The European Neanderthaler is also known to have been a cannibal. In a cave near Krapina in Yugoslavia the charred and broken osseous remains of a good forty Neanderthalers were found—manifestly belonging to men, women, and little children who had been eaten.

Only a few implements were found at the Solo River site. Some stags' horns seem to have been used as hooks, a few splinters of silicated stone showed signs of use, and some bones had obviously been broken into small pieces. Whether these sharp-pointed splinters of bone are really to be regarded as tools seems to me extremely doubtful. The most interesting objects were spheres of volcanic rock, completely round like cannon balls and the same size. Similar spheres are known from the site of Rhodesian man in South Africa and from association with the Neanderthaler of La Quina in southern France. It has been assumed that these are missiles, and it is very remarkable that such implements should have been found both in Africa and Europe in levels of approximately the same age as our Javanese deposits. A few ray-spines also discovered at Ngandong were doubtless used as spear-heads or daggers, as is still done in the South Seas. In Watualang, a site west of Ngawi, which is the same age as Ngandong but has yielded no remains of primitive man, a hippopotamus skull was found accompanied by a bone spear-head almost 8 inches long and clearly an imitation in bone of one of these ray-spines.

The fauna of Ngandong is dominated by the water-buffalo

and the banteng. The banteng is a wild ox still found in the jungles on the south coast of Java. The buffaloes are distinguished by their prodigious size: the largest has a span of more than 7 feet between the tips of the horns. And what we have are only the horns' centres of ossification. The actual horns must have been much larger. The Ngandong deer belong to two species: the living rusa deer of Java, and a relation of the Indian axis deer. There was a large hippopotamus with orbits placed high up and bony processes above the upper canines, which probably served to steer floating leaves and pieces of wood away from the animal's eyes while it was swimming. The rhinoceros was of a kind still existing in Java. We found two species of elephant: one of them is close to the Indian elephant, the other is the last representative of the remarkable stegodon, which we have already met on our visit to Trinil. A fine large tiger's skull had been smashed in at the back, probably by man. We found a small piece of the lower jaw of a wild dog. Pigs were numerous; and typical of our terrace deposits is a form with greatly elongated back molars, a new species that we named *Sus terhaari* in honour of ter Haar.

All in all, the fauna of Ngandong gives the clear impression of being more recent than the Trinil fauna, which is borne out by the human remains. This meant that we had discovered the first fossil-bearing deposits subsequent to the famous Trinil strata. But we had not thereby solved the *Pithecanthropus* problem.

Solo man's position in the human family tree has not yet been incontrovertibly established. Several anthropologists, in particular Weidenreich, see in him a direct forerunner of the living Australian, whose presence on Java Dubois had already detected with the discovery of the Wadjak skull. This is not impossible, but nor is it proven, and no final verdict can be passed until we have more complete material relating to Solo man.

We must nevertheless be grateful for having found so many skulls in the river deposits of Ngandong. Let us not forget that almost all European finds come from caves, in which man was forced to seek shelter from the rigours of the Ice Age climate. In the tropics living conditions were always much better, and man had no interest in the damp caves inhabited by snakes, bats and evil spirits. Hence in the tropics the caves are generally empty. What we find in alluvial sediments are mostly relics of men who perished in the proximity of the river. In the whole of Europe, throughout the years, only five discoveries of primitive man are known to have been made in old deposits of sand and gravel. These are the Heidelberg jaw, for which Professor Schoetensack had waited more than twenty-five years; the Steinheim skull, for which Dr Berckhemer had waited equally long; the two skulls from Saccopastore, near Rome; and the skull-fragment from Swanscombe, England. That is all that has been found in such beds in Europe up to the present. In Java we straight away found the remains of eleven skulls in a single site. This shows how fortunate we were to have discovered Ngandong. In German, to have a "stroke of luck" is called having a "pig", and that is why the great pig of Ngandong was called after ter Haar.

Because of the continual climatic changes, the alternation of glacial with warmer inter-glacial periods, it is much easier to classify Pleistocene deposits in Europe than in the tropics. The great water-buffaloes of Ngandong indicate that climatic conditions must have been different from those of today. With their spreading horns these buffaloes could never have moved about in the jungles of modern Java. The country must therefore have been far more open and less heavily wooded. Subsequently, at another site, contemporary with Ngandong, we found the remains of a heron that still lives in North China but does not occur farther south than the Yangtse River. Professor Wetmoore, who studied these remains, came to the conclusion that only a deterioration in the climate could have

driven this bird so far south. This makes it probable that the Ngandong levels coincide with the height of the last Ice Age, so that Solo man is contemporaneous with our classical European Neanderthaler and the man from Broken Hill in South Africa.

The Modjokerto Child

THE NGANDONG FINDS proved too recent to solve the mystery of *Pithecanthropus erectus*. The next human skull we unearthed in Java came from levels that were too old.

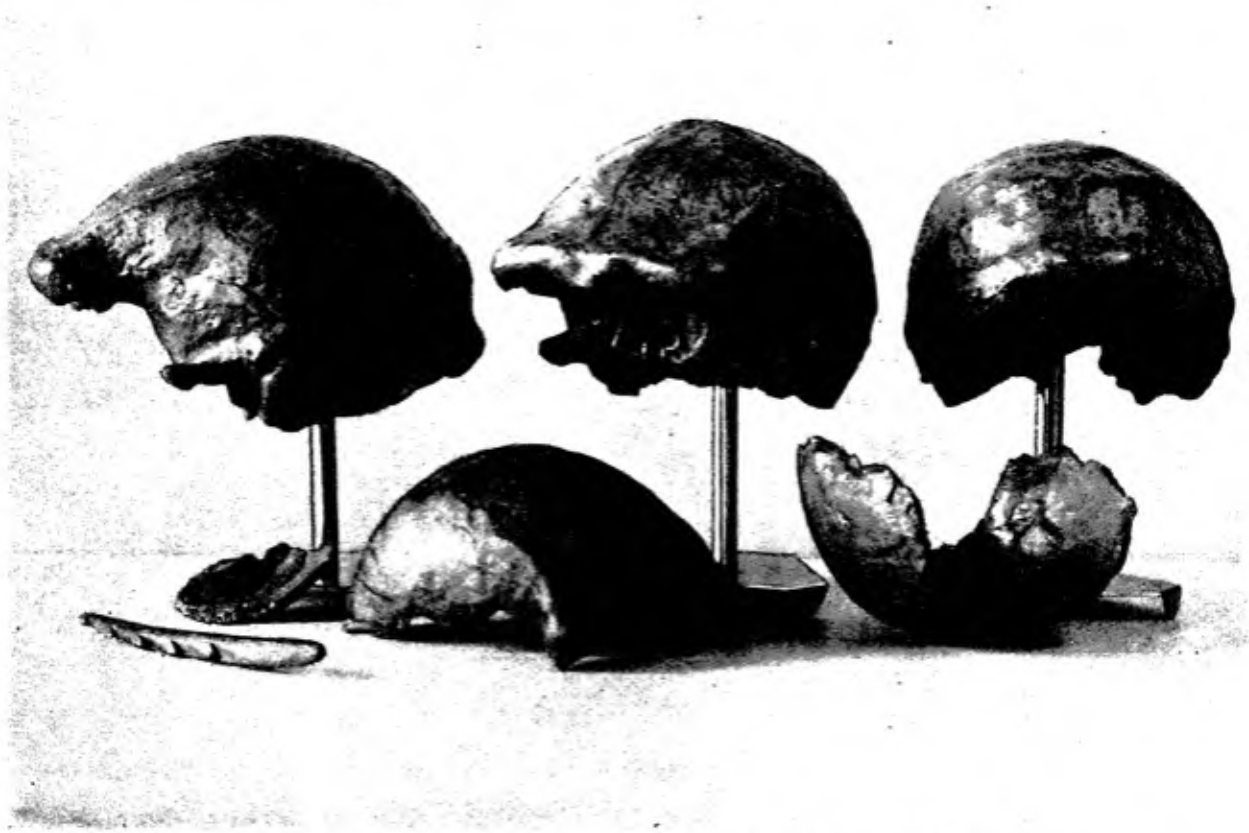
Between Surabaya and Modjokerto, in East Java, lies a hilly region of considerable economic importance as a source of oil. The hills, which run from east to west, consist of folded strata, and during the geological survey we discovered that the same fossils were to be found on the flanks of these hills as in the famous site at Trinil. The core of the hill-crests likewise consisted of sandstone, but it contained a somewhat diverse fauna. The deer was no longer the little axis deer, and the bovines were represented by the skull of a curious form, called leptobos, which had never been found at Trinil. The leptobos is a primitive ox, almost like an antelope, whose horns are placed directly over its eyes and not to the rear of the skull as in genuine bovines. Leptobos fossils are an important guide to the oldest glacial strata not only in Europe but also in India.

These formations in the Surabaya region were the first levels we had encountered that were older than the Trinil strata. The affinity of the fauna with the Early Pleistocene fauna of Europe and India must be taken as showing that these Javanese deposits are also of Early Pleistocene date. Here, at last, was proof that Trinil dated from the Middle Pleistocene, as had long been conjectured. We now made a distinction between the classical Trinil fauna (as it naturally came to be called) and an earlier fauna, which we named Djetis fauna after the *kampong* of Djetis, near Modjokerto.

The discovery that this set of strata still belonged to the Pleistocene came as a surprise. The deposits at Surabaya have accumulated in a vast river delta, and interposed between beds of sand containing mammalian fossils we repeatedly came across layers full of marine molluscs. Indeed, we found barnacles and corals firmly attached to some of the bones. The molluscs had already been described by Professor Martin as belonging to the Late Tertiary, and this served as proof that we were really at the bottom of the Pleistocene.

The fossil localities at Modjokerto were discovered by a mining engineer, Mr Cosijn, who was director of an iodine factory and interested in geology. On geological trips into the hills he had collected a quantity of mammalian remains, including the tusk of a prehistoric elephant more than 13 feet long. His finds are now in the Geological Museum at Leyden. When my colleague Duivjes had to study the area for the Geological Survey, some of the sites were already exhausted and our haul in mammals was not exactly overwhelming. Nevertheless, it contributed materially to our knowledge of stratigraphic conditions.

At the beginning of 1936 our *mantri*, Andojo, came upon the fragments of a leptobos skull in a bed of sandstone and began to dig. At a depth of only 3 feet he found a remarkable little cranium, its bones as thin as an ostrich egg, which he carefully unearthed and sent to Bandung with the comment that he had found an orang-utan skull. As soon as we had unpacked the eagerly awaited fossil we realized that it was another human skull. The cranium is only 14 cm. long and undoubtedly belonged to a child. The age cannot be established; the fontanelle is still recognizable and has just closed. In modern man this stage corresponds to the end of the second year of life; but there is no guarantee that this also holds good for fossil man. Unfortunately, the little skull no longer had any teeth; indeed the whole facial area was missing, so that the dentition could not be used in judging the age. All we could



Some crania of *Homo soloensis* from Ngandong. *Left:* a bone spear head from Watualang

The "skull-bowls" of Solo man from Ngandong. The modern skull on the left is a Dyak trophy; the foramen magnum has been enlarged to facilitate extraction of the brain

16 The child's skull of *Pithecanthropus modjokertensis* from Garatengah near Modjokerto, the first relic of Early Pleistocene man (½ natural size)

do was to compare the fossil with a human skull of the same length.

It was immediately evident that the fossil child's skull had a far lesser cranial capacity than the corresponding skull of modern man. Its childish brow, which is clearly marked, does not overhang to the front; in position it corresponds rather to that of an adult human skull. A supra-orbital ridge had not yet developed, although there were signs of constriction in the post-orbital region such as is never seen in the skulls of modern human children.

That we were dealing with a human skull was clear from the outset. But was it a *Pithecanthropus* skull? In our view it was, but when we designated the new find as *Pithecanthropus*

modjokertensis, a protest immediately arrived from Dubois with the statement that his *Pithecanthropus* was not human, and therefore this cranium could not be a *Pithecanthropus*. For this reason the new primitive man was christened simply *Homo modjokertensis*, but the skull was referred to in the text as that of a *Pithecanthropus*. This seemed to us a diplomatic solution to the problem of nomenclature. None the less, Dubois made difficulties. Not only did he deny that the fossil was of Early Pleistocene date, although he knew nothing of the circumstances or locality of the find, but he also asserted uncompromisingly that the Modjokerto child belonged to Solo man.

The Modjokerto child greatly increased our knowledge of Pleistocene man in a general sense, being the first find belonging to such an early geological period. But we had come no closer to solving the *Pithecanthropus* riddle. Only a new *Pithecanthropus* skull could help us with this.

The Second Skull

THE FINDS IN THE TRANSVERSE valley of the Solo and in East Java had at least assisted us to classify Java's Pleistocene stratification and fix the geological age of the *Pithecanthropus* horizon. We had met the most recent Pleistocene deposits in the Ngandong terraces, with *Homo soloensis*, the Javanese Neanderthaler. Below this must lie the Trinil level with the still disputed *Pithecanthropus erectus*, and still deeper came the Djetis strata with the child's skull of *Homo modjokertensis*. We now had two possible ways of solving the mystery of *Pithecanthropus*: either to find a new *Pithecanthropus erectus* in the Trinil beds, or to unearth from the deeper formations an adult *Homo modjokertensis*, which in our opinion must also be a *Pithecanthropus*.

The finest and most extensive collection of evidence came to light at Sangiran in the dry season of 1934. Sangiran had long been known as a fossil locality. Here were found the first elephant teeth which the Javanese painter Raden Saleh—

incidentally, a pupil of the great Delacroix—sent to Leyden, thereby enabling Professor Martin to establish the presence of the Indian Siwalik fauna in Java and the diffusion of the Indian fossil elephant down to this point. Dubois also collected fossils here in 1893. This site seems not to have made any particular impression on him. He merely mentions it in his report, without having returned for a second visit. Van Es, one of our colleagues in Bandung, had recently had a large-scale map of the district drawn. A big collection of marine and freshwater molluscs had already been placed in the Bandung Museum, as well as a few bones and teeth.

On the first occasion I had been on a tour of inspection in East and Central Java with several colleagues. This time I took with me Atma, my faithful collector. I had discovered him working as a gardener for friends of mine. When he heard that I was interested in prehistoric finds he appeared one day with a magnificent stone axe, whereupon I took him into my service as a collector, and he was my truest companion for almost ten years. When I had money, he went out on his own collecting stone implements, fossils or masks for me. When I had no money to spend on my collection, he acted as our servant, cooking for us and seeing to our washing. During my tours of Java he was absolutely irreplaceable. His father came from Macassar on Celebes, his mother was a fair-skinned Sundanese, and his mixed blood rendered him more open and communicative than the otherwise very reserved Javanese. I owe to him my knowledge of many Indonesian customs.

Atma had hunted up a taxi for us at Surakarta, our scanty luggage was piled in, and off we went. First we travelled northwards along the broad highway as far as Kalioso, about 10 miles from Surakarta. Then the route became more difficult. We turned right into a secondary road, soon found ourselves among rice-fields and came to a halt at a small stream. The bridge was down and would remain down, for nobody here used carts or cars. While Atma walked back a few hundred

yards to the *kampong* to fetch coolies for our luggage, I began slowly to climb the hill.

It was a broad hill with a regular, gentle slope. The fields had been reaped and now, since it was the dry season, lay parched and bare. The air was bright and clear and the view glorious. The lofty volcanoes gave the landscape a typically Javanese stamp. Behind me loomed dormant Merapi, whose plume of smoke proves that it is still dangerous; in front of me towered Mount Lawu, which is also visible from Trinil. Trinil and Sangiran are about 40 miles apart as the crow flies.

I have always had a great liking for the enigmatic Lawu. Near the summit stands an ancient shrine, the Tjandi Sukuh. It is the only temple of its kind in Java—a stone pyramid with a flattened apex reached by a narrow stairway. The sanctuary has an almost Mexican appearance. A few Hindu ornaments have been carved at the foot, but it can be seen at a glance that these are far less weathered than the pyramid itself. The latter probably dates not from the Hindu period but from a much older cultural epoch.

The summit of Mount Lawu, about which the Javanese do not like to speak, is often visited by ascetics and those who wish to become ascetics. Like other peoples, the Javanese believe that they can develop supernatural powers by fasting and meditation. Anyone who has spent forty days and nights praying on the icy peak of Lawu—where there are supposed to be a few caves in the old lava-streams—without eating (only a little liquid may be taken), returns to his people a holy man. But very few can sustain this test of endurance; most of them come down prematurely, and many are said to have perished of hunger and cold on the mountain.

As we have already seen, Java's volcanoes dominate not only its geography but also its geology. A large proportion of its strata are composed of volcanic material, and here too, on the hill of Sangiran, great angular blocks of dark volcanic rock betray the old rivers of rubble that once spread across the land.

Once at the summit, I saw a remarkable sight: I was standing on the rim of a large, almost circular depression with steep sides, that looked almost like a crater. It was about 2½ miles across and the other side was clearly visible from where I stood. The morphology of the landscape at this point revealed the secrets of the subsoil with a clarity I have rarely seen. The strata had been pushed up as though by an enormous thumb. This must have taken place quite slowly, for the little river, the Kali Tjemoro, had kept to its old course and cut deep into the summit, instead of following the easier path round it. Weathering had then eroded the hill and carried it away, so that the strata lay exposed like the layers of a cut onion—the most recent strata on the outside, the oldest in the centre. And since the Kali Tjemoro drained the district and, in the rainy season, carried off all the products of weathering in the shape of a dark stream of mud and conveyed them to the great River Solo, nature had here arranged the strata according to their natural hardness. We stood at the edge of a roughly 70-foot-thick layer of hard tufa and sandstone, ending in a rocky declivity. Beneath this lay strata of clay, which were heavily eroded and had thus formed a deep, almost circular valley. Here, on the impermeable clay soil, the Javanese had planted their irrigated rice-fields. And in the centre, forming a hill, lay harder strata that had offered greater resistance to weathering. On this hill stood maize-fields and roughly in the centre of the great hollow, encircled by coco-nut palms, the *kampong* of Sangiran.

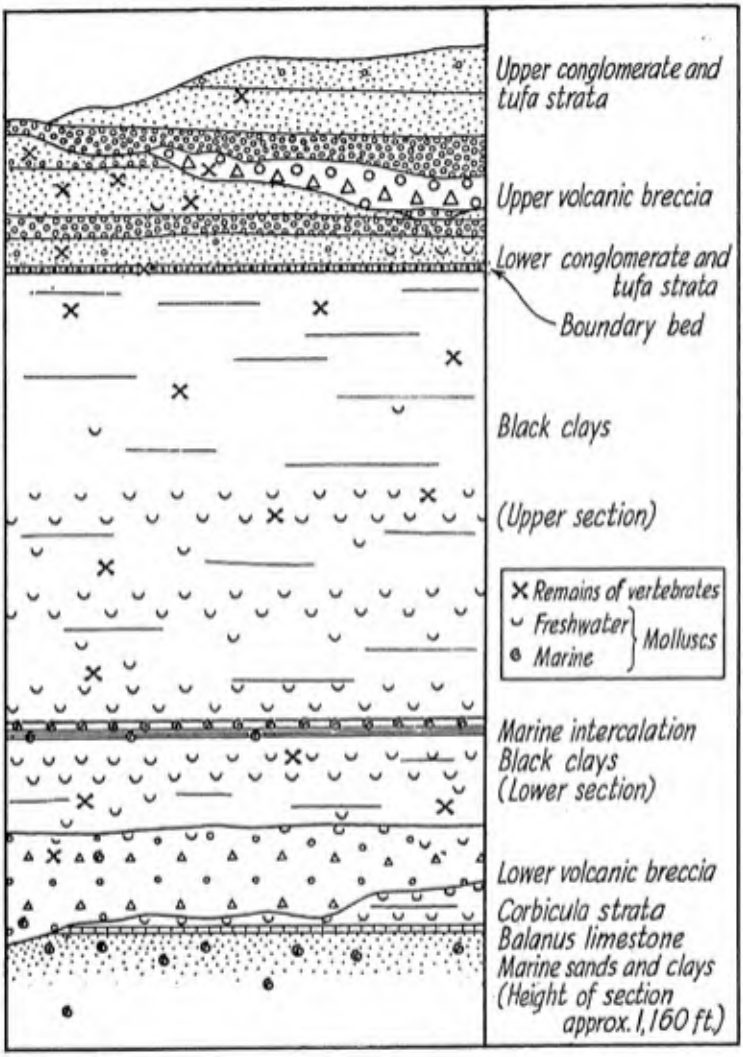
As we climbed down we found all over the fields, embedded in a black clay, innumerable shellfish and snails, which undoubtedly originated in freshwater deposits. Only a narrow yellow band, less than 2 feet thick, testified to a sudden, brief invasion by the sea. Sangiran Hill itself consists of a semi-volcanic hard sandstone with many pieces of rock, a so-called *lahar*, i.e. an old river of volcanic debris.

Close to the roadside, before the ascent to the *kampong*, a few dirty grey hillocks surrounded by puddles of water stood

among the fields. As we approached, a number of women and girls fled in terror, leaving behind their jugs filled with water. At the time we could not understand the reason for this panic: later we learned that in these mud hillocks the salt springs emerge. The salt water is secretly collected by the local inhabitants in jugs and evaporated; but since in Java, as in most other countries, salt is a State monopoly, it is strictly forbidden to do so. The people therefore had bad consciences and took me (what else could a white man be doing in such a remote spot?) for an official who had come to check up on them. Their anxiety was not allayed until they were convinced that I was only interested in shells and teeth.

As our *mantris* had already done some collecting here, the local population knew what was expected of them. They brought us bones and teeth that had been found in the fields, and took us to a little stream, a tributary of the Kali Tjemoro, that had cut into Sangiran Hill and laid bare the formations beneath the sandstone. First came a bed of hard limestone about 6 feet thick, which oddly enough consisted exclusively of the broken shells of barnacles and must have been deposited in a zone between high and low tide. Below this lay blue-green sandy clay, with hundreds of splendidly preserved sea-shells and snails, and soon we had also found some sharks' teeth. Particularly numerous were the big, pointed turret snails, up to 8 inches long, of the genus *Turritella*. We suddenly had a feeling of being on the bottom of the sea. In tropical waters the molluscan fauna is much more varied than in the Mediterranean or the North Sea, and is quite differently composed. Many more species are to be found, but of each species only a few examples.

It was easy enough to reconstruct the history of Sangiran from the geological profile we had traversed. The sea had originally been in control here, until movements of the earth's crust caused the land to rise. The limestone bed corresponds to a coastal deposit. The area was cordoned off by a river of



17 Simplified geological cross-section of Sangiran

volcanic mud (perhaps from a primeval Merapi), and thus a fair-sized lake came into being. Once more, and for a short time only, the sea returned. We later found a similar succession of strata farther north at Baringinan, and here the interposed marine bed was 6–10 feet thick: the sea had, therefore, come from the north, from the region of the present Java Sea. After this the sea-basin was filled in with more black clay and finally turned into land. In the upper levels the shells exhibited a thick crust of lime, and at some points a bed of limestone had even formed. Above this—it must have been an extremely turbulent period—the tufa and sandstone, which we noted at the beginning of our examination, was deposited by rivers and by streams of mud.

There was great rejoicing in the *kampong* over our arrival. The men gathered together all the jaws and teeth they could lay hands on and offered to sell them to us. Even the women and girls, who are generally so retiring, took part. In this region of Java the women retain throughout life a childish forehead that is tilted forward, giving their profile a look of touching helplessness.

The best localities for bones and teeth lay at the foot of the steep declivity. So we spent the late afternoon and the following morning wandering round the whole basin. On all sides lay fossils that had been freed from the sandstone by weathering or erosion. Those that had been lying there for a long time had naturally disintegrated, and the larger bones, especially, were beyond saving. Later we learned that a good harvest could be reaped from the hills after every fall of rain, and in this way we obtained much fresher material.

Our very first collecting expedition was a great success. We found jaw-bones and pieces of antler belonging to the little axis deer, and jaws and teeth of the small *duboisia* antelope, both not uncommon at Trinil. Our sandstone stratum must, therefore, correspond to the Trinil horizon. Remains of elephant were also numerous. Most of the teeth belonged to the

low-crowned stegodon; the higher teeth of the true elephant were much rarer. In the first two days we found remains of three jaws and two skulls. The mandibles were easy to exhume, but where the crania were concerned we had our work cut out merely to secure the teeth. Such an elephant skull looks massive from outside, but the brain space is small and the rest of the cranium consists of thin-walled air cells. If the outer wall has been damaged by erosion or wholly weathered away the skull looks at first sight like a mass of coral with innumerable irregular openings. Elephant skulls affected by weathering fall apart at a touch and cannot be saved.

The striking abundance of fossils in the Trinil levels, which could be followed in a closed circle around the whole basin and also in all the countless little side valleys, opened up unexpected vistas. Here, I felt on the first day, a *Pithecanthropus* would eventually be found. But when?

The black freshwater clays formed a gently undulating surface. During the dry season they became as hard as stone and were riddled by crevices several yards deep: in the rainy season they were so squelchy and viscous that we almost lost our shoes. Here collecting was not easy, but we soon discovered the little rusa deer known to us from Modjokerto, and horns of the leptobos. The lowest series of strata at Sangiran, down to the base of volcanic conglomerate, therefore correspond to our Djetis levels in East Java. We had before us the same succession of strata we had first discovered at Surabaya, only our new site was much more productive.

That was my first visit to Sangiran, which was to be followed by many more. I lived for weeks in the little *kampong* of Krikilan, which was not so far from the main highroad as Sangiran, and I always felt particularly at home among the peaceful, quiet inhabitants of the district. Without their intelligent co-operation (there cannot have been anyone in the whole neighbourhood who did not join in the collecting) we could never have achieved the results that were later to be ours.

But first I had to return to Bandung. One of our trained *mantris* went to Sangiran and began excavation (as earlier at Ngandong). Our expectations were not fulfilled, however. Bones and teeth were distributed throughout the strata, but only in insignificant quantities. The abundance of material was due to the extent of the area in which rain had washed out the fossils and swept them together—not its concentration at particular points, as at Trinil. Nevertheless, some important finds were made at this period. There was a coarse, pointed tooth that must have belonged to a hyaena, and our first lower jaw of a sabre-toothed tiger. The canine teeth of the sabre-toothed tiger, which give it its name, are not relatively short and pointed like those of the ordinary tiger, but flat, sharp and as long as knives. Such an animal cannot leap on its prey like a tiger, firstly because it has only a short stump of a tail, and secondly because in so doing it would inevitably snap off its thin canines. It is believed that sabre-toothed tigers were specialized carrion-eaters. With their long teeth they could more readily open carcasses inflated with putrefaction gases than their unspecialized fellows, and so get more easily at the blood and viscera that were probably the articles of food most sought after by these great cats. The sabre-toothed tigers are now completely extinct, although many species were once distributed over both the Old and the New World. In some American varieties the canines became so large that they could scarcely open their mouths. And that is the end of everything, even for the sabre-toothed tiger.

A severely damaged fragment of skull and a few teeth gave us the first intimation of the presence on Java of the chalicotherium. This, too, is a totally extinct animal, a representative of the perissodactyls—animals with an odd number of toes on each foot—which include the tapir, the rhinoceros and the horse. Further, we found a large number of rhinoceros teeth and a few belonging to the tapir. Fossil horses occur neither in South China nor Indonesia. The chalicotherium was about the

size of a horse with huge claws on its feet. The first such claw was unearthed about a century ago in Rhenish Hesse, Germany. At the time, palaeontology was still in its infancy: consequently the great Cuvier, the founder of mammalian palaeontology, could make the mistake of imagining behind the giant claw a giant sloth (today we know better), while he attributed large double-ridged teeth to an enormous tapir, which later turned out to be a curious type of elephant, the dinotherium (from the Greek *deinos* terrible and *theiros* wild beast).

18 Hyaena's tooth from Sangiran, thick and pointed and adapted to gnawing bones (natural size)

It is unlikely that the chalicotherium could have dug or grubbed up roots with its claws, as some palaeontologists supposed. Its low-cusped dentition suggests a soft, vegetable diet. Nowadays it is thought more likely—since the hind legs were much shorter than the fore legs—that the chalicotherium balanced itself on its hind legs and thrust the long claws of its fore legs into the tree-tops and thus browsed at its ease. With its long neck the giraffe has an easier time nibbling what it likes from the tops of the trees. The chalicotherium proved to have been an evolutionary mistake. In Europe it died out in the Lower Pliocene—i.e. about 10 million years ago; in Southern Asia and Java it held out till the Lower Pleistocene, and in Central Africa to the Middle Pleistocene.

Work at Sangiran had to be stopped in December 1934. Times were difficult, and the new geological survey of the archipelago that had been started with such enthusiasm, and for which so many foreigners had been engaged, was senselessly abandoned with no thought for all the progress already made. My post as mammalian palaeontologist ceased to exist, and I was discharged.

But it was impossible for me to drop my work. Atma was sent to Sangiran (at this point he Javanized his name to Atmowidjojo), to keep an eye on this most important fossil locality and look out for possible human fossils. He received in all 25 gulden a month: 15 were his salary, the other 10 were to enable him to purchase important fossils.

My Dutch colleagues and my trusted wife saw to it that I received an allowance that would permit me to carry on. At this critical moment our colleague Teilhard de Chardin came to Java. Teilhard—a member of the order of Jesuits—is a Frenchman and had made a name for himself with his work on the lemurs of the French and Belgian Tertiary. He later went to China. He was a friend and collaborator of Davidson Black, and his name is also closely linked with Peking man. Now he was once more on his way to China and had taken the opportunity of making a trip to the island of *Pithecanthropus*.

Sangiran also made a deep impression on Teilhard. He advised me to get in touch with the Carnegie Institution of Washington, whose President, John C. Merriam, was a well-known American palaeontologist. I wrote Dr Merriam a long letter setting out my palaeontological and personal difficulties. "I have", I wrote to Washington, "found a new fossil locality here in Java; if a *Pithecanthropus* is to be found anywhere, it will be here."

To my surprise and delight, Dr Merriam began to take an interest in *Pithecanthropus*. He sent me an invitation to attend a congress in Philadelphia, at the beginning of 1937, concerned especially with fossil man.

The meeting in Philadelphia was important to me in every respect. I made the acquaintance of my American colleagues; Teilhard was there too; and it was my first meeting with the temperamental Dr Robert Broom, who later caused so much excitement with his finds of man-apes in South Africa and with whom I remained in contact until his death in 1952. But most important of all was the fact that Dr Merriam appointed me a Research Associate of the Carnegie Institution and placed a considerable sum at my disposal to pursue the search for fossil man in Java.

The first thing I did was to write Atma a long letter in my best Malay and send him by air mail a cheque to finance the work at Sangiran. I myself returned to Java by a route that took me to Japan and China. In Peking, accompanied by my old friend Young, I visited the site of Peking man and hunted the drug stores of Peking, Nanking and Hong Kong—with great success—for dragons' teeth. In June I was back in Java.

The first basket of fossils I received from Sangiran contained a striking fragment of mandible that could only belong to a human. It had been found during my absence, and I at once set out for the site. This was situated in the area of black clay directly to the east of Sangiran. The fragment of jaw was partially embedded in a conglomerate, and my first impression was that it came from the hard Trinil sandstone and that the rains had swept it down into the black clay area. I described it as a jaw-fragment of *Pithecanthropus erectus*. Criticism from old Dubois followed without delay. Dubois had himself discovered a small fragment of jaw, which looked quite different, and he asserted that my jaw—which was certainly human—must belong to *Homo soloensis*. This was quite impossible, of course, since the Ngandong fauna was absent from Sangiran. Dubois would not concede that this jaw-bone could have belonged to a *Pithecanthropus*. Later we found out that the jaw did, after all, originate in the black clay and therefore could not be Dubois's *Pithecanthropus*, but must have belonged to an older form.

The mandible itself is strikingly large and devoid of chin. The whole of the right half of the jaw with the three molars and the last premolar was preserved. The rest of the teeth had fallen out, and it could be clearly seen that the eye-tooth had been small. The most remarkable thing about this jaw is the relative size of the teeth. There is an increase in volume from

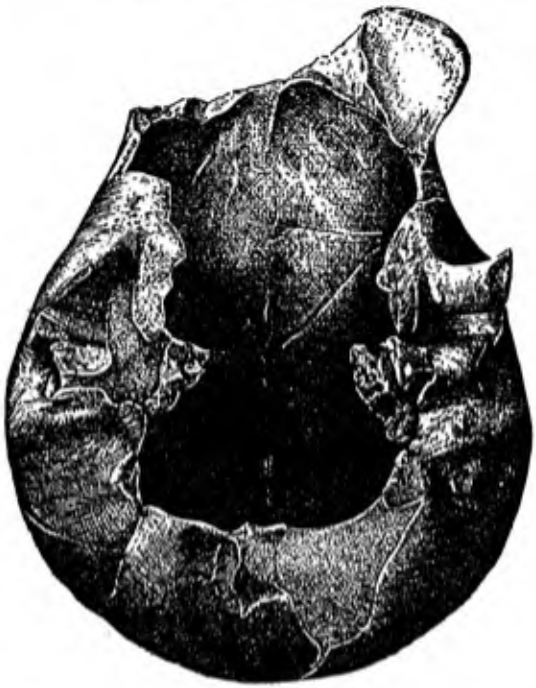
19 The first *Pithecanthropus* mandible from Sangiran. Originally attributed to *Pithecanthropus erectus*; it was later evident that it came from an older level and belonged to *Pithecanthropus modjokertensis* (natural size)

the front to the back, i.e. the first molar is the smallest, the second somewhat larger, and the third the largest of all. Such a primitive arrangement is normal for the great anthropoid apes. In all other fossil human jaws—such as those of Peking man, the Heidelberger or the Neanderthaler—the last molar is already smaller, and in modern man the relationships are different again. Here the second molar, too, is generally so reduced that the first is the largest in the row.

This feature rendered the Sangiran mandible the most primitive fossil human jaw yet found. But we could not convince Dubois.

When we began to collect at Sangiran we said nothing to our Javanese helpers about the possibility of discovering human remains, although these were naturally the finds we were waiting for. The Javanese is very superstitious and dislikes coming into contact with human bones. Everything originating from the body can all too easily be misused for purposes of witchcraft. If he has a tooth extracted he takes it away with him and buries it where he is sure no one will find it. He is also extremely careful with hair and nails, and even with worn clothes. Every year, even today, the old sarongs, the nail parings and the hair of the Sultan of Jogjakarta are thrown into the crater of Merapi, so that they shall not fall into the hands of anyone who might possibly use them as a means of bewitching the Sultan's person. On the steep hill-side of Sangiran, human bones and teeth were continually being exposed by the action of rain; they came from old graves, and we had to offer special rewards to get them collected at all.

At the beginning of September I received a letter from Atma telling me that they had unfortunately not yet found any orang-utan, but that they had unearthed a fragment of human skull; and he enclosed the temporal bone of a thick, splendidly fossilized cranium. I took the night train to Central Java the same evening, and next morning I was at the site. This lay on the bank of the Kali Tjemoro, at the point where it breaks through the sandstone of the Trinil formation. We mobilized the maximum number of collectors. I had brought the fragment back with me, showed it round, and promised 10 cents for every additional piece belonging to the skull. That was a lot of money, for an ordinary tooth brought in only ½ cent or 1 cent. We had to keep the price so low because we were compelled to pay cash for every find; for when a Javanese has found three teeth he just won't collect any more until these three teeth have been sold. Consequently we were forced to buy an enormous mass of broken and worthless dental remains and throw them away in Bandung—if we had left them at Sangiran they would

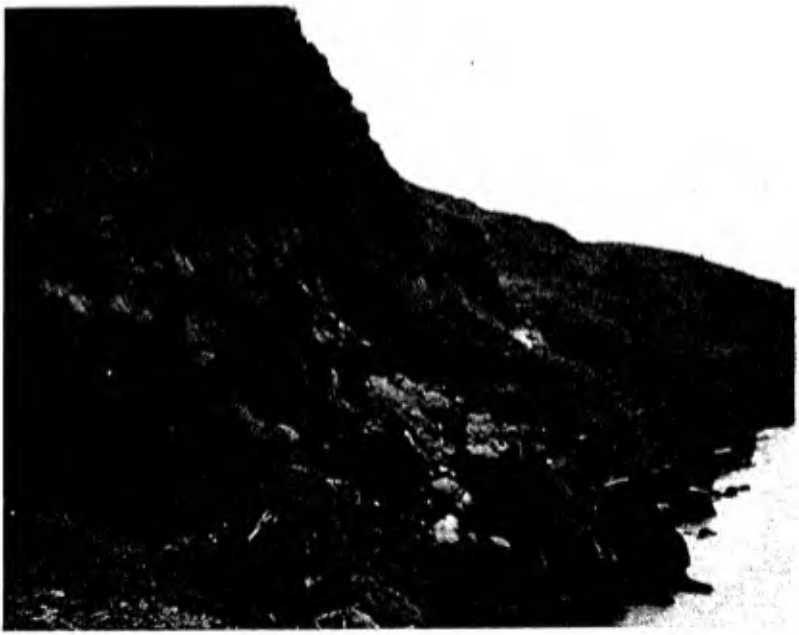


20 The *Pithecanthropus* skull, seen from below, shows in front the remains of the massive supra-orbital ridge and clear impressions of the convolutions of the brain, at the side the deep glenoid cavity for the lower jaw, and at the back the rim of the foramen magnum ($\frac{1}{2}$ natural size)

have been offered to us for sale again and again! In spite of the low price, we used to pay several hundred guilders a month for fossils.

Cautiously we began to hunt through the hill-side foot by foot, and soon the first fragments of skull did really come to light. Unfortunately, they were extremely small: too late I realized that my opportunist brown friends were breaking up

Pithecanthropus erectus II, seen from the left



The site where *Pithecanthropus erectus II* was found was right on the bank of the Kali Tjemoro

The cranial fragment of *Pithecanthropus erectus III* found at Sangiran in 1938, filled with volcanic tufa

The site at Sangiran where *Pithecanthropus erectus III* was found lay in the typical tufa beds of the Trinil formation. The spot at which it was unearthed is marked by the white sola topi

the larger pieces behind my back, in order to get a bigger bonus. I had the good luck to find part of the frontal bone with the eyebrow ridge myself. We hunted on into the afternoon and found in all forty fragments. It was already perfectly clear that we had discovered a new *Pithecanthropus* skull.

We wound up the eventful day with a feast. We distributed rice and salt, laid on a *gamelang* orchestra, and the village's three dancing girls even put in an appearance. The latter were heavily made up and no longer in their first youth; they were so-called *rongengs*, who lived outside the village with an old woman and were celebrated for their love charms and love potions.

The skull was carefully reconstituted at Bandung by our excellent preparer, Herr Bormann. It was more complete than I had expected. There was nothing missing from the calvarium save a small piece of the front edge, which was easily made good by exactly copying the perfect side; at the back the skull was preserved down to the rim of the foramen magnum. Above all, the temporal regions were there, together with the ear and the deep glenoid cavity for the lower jaw. We had found nothing more of the face and upper jaw.

Now, the region round the ear is decisive in answering the question, Man or ape? In the ape the ear lies more or less in the prolongation of the zygomatic arch, but in man it comes lower down. In the ape the fossa of the temporo-maxillary joint is shallow, in man deep. It was quite clear that our skull must be human. But there was more to it than this. In its mighty supra-orbital ridge and the length and breadth of the brain-case it tallied so exactly with the famous Trinil fossil (it even showed the same slight crest formation on the frontal bone and other minor details that might easily have been mistaken for individual variations) that there could be no doubt it was a *Pithecanthropus* skull. This find, therefore, proved at last that *Pithecanthropus erectus* was human.

After the skull had been reconstituted I immediately sent a

preliminary photograph to old Dubois. I thought he would share my joy that the problem had finally been solved, even though the new find did not confirm his current opinion; I hoped he would simply declare that his first impression of *Pithecanthropus* had been right after all. I was very much mistaken, however. To my horror, I received a copy of an article

21 Seen from behind, the *Pithecanthropus* skull clearly shows the sloping walls of the calvarium. The maximum width of the cranium is at the level of the ears, and not above them as with us ($\frac{1}{2}$ natural size)

printed in Holland, in which Dubois had published the photograph I had personally sent him, together with another photograph on which the fragments lay side by side. Without paying any attention to perspective, he had measured the loose fragments and come to the astounding conclusion that the same fragments as fitted together in the cranium had become smaller by 10 and 18 mm. He indirectly accused me of having faked the skull. He was, however, compelled to admit two facts: that

the skull was human, and that the cranial curves were similar to those of his *Pithecanthropus*.

A sharp protest I sent to Holland was not accepted for publication. But Dubois was prevailed upon to retract his assertion. He did this in a manner that was almost more insulting to me than his original remarks. He did not wish, he wrote, to insinuate that I had intentionally altered the shape of the cranium in putting it together; the skull consisted of so many fragments that even he, with fifty years' experience in this field, could probably not have reconstructed it in its original form.

This last comment was sheer nonsense; for the skull was more than 1 cm. thick, and for this reason it was child's play to fit the pieces together. Above all, the interior of the cranial vault was practically intact; we had only to fill a few holes in the surface with plaster of Paris in order to obtain internal casts. Since all the plaster of Paris is coloured black in our illustration, it is difficult to form a clear picture of the skull from this alone.

One of the objections raised by Dubois was that the new skull was too lofty for a *Pithecanthropus*. In his find he had interpreted a piece of bone projecting from the right side as the remains of an ear-bone—why, is not clear, for it is evident from the plaster cast of the skull that the ear must have come much lower. As a result the cranium was far too low in reconstruction. Our find completely confirmed Weinert's view that the ear must have been situated a great deal lower down, and we were later able to prove by the most modern means that our new skull had been correctly reconstituted. Under the X-ray the cranial sutures, which had grown together and were no longer visible from outside (except in the temporal region), stood out clearly, and their uninterrupted course was the best proof of the accuracy of our reconstruction.

In the meantime, however, the soundness of our interpretation had been confirmed from another quarter. A peculiarity which *Pithecanthropus* shares with *Sinanthropus* is the striking

thickness of the cranial bones, already mentioned. The convolutions of the brain are much more clearly marked on the inside of the cranium than is the case with modern man; it is as though the growing brain had been so forcibly cramped by the skull that the convolutions had pressed into the bone. In any case, our find yielded a particularly fine brain-cast, the study of which was undertaken by Professor K. H. Bouman of Amsterdam. Working in conjunction with the celebrated anatomist Ariens Kappers, he was able to establish a very clear concordance between the casts of *Pithecanthropus I* and *II* not only in the sphere of cerebral convolutions but also in the ramification of the arteries, which are generally subject to particularly marked variations. This showed not only an outer but also an "inner" resemblance between the two *Pithecanthropus* fossils.

The speech centre is localized in the third frontal convolution, known as "Brocca's centre". Dubois believed that it was already clearly demarcated in *Pithecanthropus*; other scientists were more cautious. That *Pithecanthropus* could speak—and was not, as Haeckel thought, a *Pithecanthropus alalus*—is rendered probable by certain anatomical peculiarities of the lower jaw, to which we shall return later.

The original shape of the cranium was easily reconstituted, and so it became possible to measure the cranial capacity. This proved to be only 775 c.cm., and it was undoubtedly a fully grown individual, for the cranial sutures, with the exception of those in the temporal region, had all closed up. In modern man the cranial capacity is normally between 1,350 and 1,500 c.cm.; the smallest crania of Peking man and also of Solo man have about 1,000 c.cm. Hence this skull possesses the smallest cranial capacity yet recorded in fossil man. This, together with the massive eyebrow ridges, points to the extreme primitiveness of our *Pithecanthropus*.

Now, Dubois, when he rejected the human character of *Pithecanthropus*, cast fresh doubts on *Sinanthropus*, which he held to be a degenerate Neanderthaloid. The new find at last

gave us an opportunity of directly comparing *Pithecanthropus* with *Sinanthropus*. So I received an invitation from Professor Weidenreich at Peking to come to that city with the new *Pithecanthropus*. We made the journey at the beginning of 1939, and there, at the Rockefeller Institute, we were finally able to examine the affinities of these two primitive humans.

We laid out our finds on the large table in Weidenreich's modern laboratory: on the one side the Chinese, on the other the Javanese skulls. The former were bright yellow and not nearly so strongly fossilized as our Javanese material; this is no doubt partly owing to the fact that they were much better protected in their cave than the *Pithecanthropus* finds, which had been embedded in sandstone and tufa. Every detail of the originals was compared: in every respect they showed a considerable degree of correspondence. The frontal bone is more rounded in *Sinanthropus*, and therefore the continuous supra-orbital ridge stands out more sharply than in *Pithecanthropus*, but in compensation the latter's posterior parietal bone is more arched than in Peking man. A depression the size of a coin in the posterior parietal region, visible in *Pithecanthropus III* and easily mistaken for an individual variation, was found in exactly the same form in *Sinanthropus* Skull E. The two types of fossil man are undoubtedly closely allied, and Davidson Black's original conjecture that *Sinanthropus* and *Pithecanthropus* are related forms—against which Dubois threw the whole weight of his authority—was fully confirmed by our detailed comparison. Unfortunately, our carefully documented joint statement could only be published in a much abridged form, on account of the war that had meanwhile broken out in Europe.

Sangiran proved an unusually productive locality. In 1938 a small piece of a juvenile *Pithecanthropus* skull was found in the tufa of the Trinil levels south of the hill-top, about ½ mile from the 1937 site. Now officially designated *Pithecanthropus III*, it consisted solely of a fragment of the occiput and the two

parietal bones, of which only one was complete. In modern man this bone is much longer than it is high; in *Pithecanthropus* it is roughly square. The cranial sutures were still open, despite the fact that the cranial bone was already 0·5 cm. thick. Close by the road at Krikilan we had found isolated maxillary teeth from skulls otherwise totally destroyed by weathering, and it took

22 Stone implements from the Trinil level at Sangiran (⅔ natural size)

more than a year before we had obtained four maxillary teeth belonging to one and the same jaw. They were no larger than the same teeth in modern man. At another site a first lower premolar was found, the duplicate of a *Pithecanthropus* tooth obtained by Dubois at Trinil. This find convinced us that our *Pithecanthropus* must have had small teeth, or at any rate teeth no larger than those of modern man or of the Heidelberg jaw, unlike the large-toothed Peking man. For this reason alone it is unlikely that the latter, strictly speaking, is merely a Chinese *Pithecanthropus*, as some anthropologists tend to think.

Peking man also possessed tools. Where did *Pithecanthropus* stand in this respect? Prolonged search failed to bring to light anything of the sort in the skull level, but we unexpectedly

came on some primitive stone implements a little higher in the profile.

The best site was the summit of a tall hill north of Krikilan, on the top of which lay an accumulation of coarse gravel, containing implements, unfortunately without accompanying fauna. At other points, however, we found the same implements accompanied by Trinil fossils, which convinced me that the main group of tools originated from the *Pithecanthropus* level, although no fossils were found with them.

The instruments are small and obviously consist of flakes. As is usual with such pieces, one side is smooth and shows only the bulbar or "conchoid" cone displaying the concentric rings laid bare by percussion. The other, more regular side has been retouched, or at least shows signs of use. These tools are extremely irregular in shape. They are practically all scrapers. But there are also a few simple points, and one or two specimens have been so finely worked that they are entitled to be called primitive borers. The material is silicated limestone, yellow or brown, with a fine, lustrous patina that bears witness to their great age.

Our implements can be only indirectly compared with those of *Sinanthropus*, since the latter employed a different material —quartz—and hence a different technique. None the less, a certain basic resemblance may be observed. Europe has yielded similar primitive flake tools of great age. They belong to the so-called Early Clactonian—after the site at Clacton in Essex —and date from the interglacial period between the second and third glaciations; hence they may well be coeval with our Sangiran culture.

Workers in China had the good fortune to meet *Sinanthropus* at home, so to speak; that is to say, they found a spot where he lived and where he left behind his refuse and tools. In Java we have not yet been so lucky, and consequently we are not so well informed concerning the old gentleman's habits of life as we are about those of his Chinese contemporary.

Further surprises at Sangiran were the spheres of black glass we discovered while looking for stone implements. These spheres, too, have a long history. They are familiar from Australia, where—like any other shiny object—they are picked up by emus and later appear in the contents of the birds' stomachs. Darwin was already struck by these so-called australites. Similar glass balls, their surfaces queerly corroded, were found during prospecting for tin on the island of Billiton off Sumatra, and received the name billitonites. They have also been found in Malacca, Indo-China, on the island of Hainan, in Borneo and the Philippines. At first glance the material resembles obsidian, a black volcanic glass, but they occur chiefly in districts where there are no other signs of volcanic activity. Besides which, obsidian always shows marks of crystallization, and when strongly heated it swells up through the expulsion of gas, turns light in colour and porous, and becomes pumice-stone. A billitonite consists of pure glass, and when heated it melts in great drops. Chemically, too, there are certain marked differences.

Nowadays it is believed—here too, of course, there are learned doubters—that these billitonites are of cosmic origin. Not a single case of a glass meteorite is known from historic times, but in the geological past they seem to have descended on the earth from space in huge swarms. The remains of one swarm of green meteoric glass have been found in Europe—in Czechoslovakia. Here, in the heart of the Central European glass industry, people first thought that the curiously shaped little pieces of glass derived from prehistoric or early medieval glass-works, although they were always and only found in river gravel. They were not recognized as meteorites until 1900. These European glass meteorites must have fallen in the Tertiary epoch—some 20 million years ago.

Our billitonites are certainly very much more recent. All the finds have been made on the surface or in tin placers and gravel terraces. Here at Sangiran we found them for the first

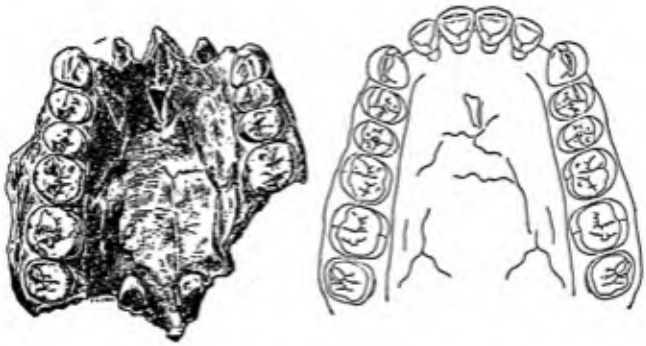
time in association with fossils that provided a pointer to their geological age. They came from the upper Trinil levels. Not until 1953 did we come across another fossil locality, on the Philippines, in which billitonites were likewise associated with the teeth of stegodons and elephants, indicating that this site was the same age as our Javanese one. It looks, therefore, as though towards the end of the Middle Pleistocene a tremendous rain of billitonites, consisting of several swarms, fell on our earth in the area between Australia and South China, Malacca and the Philippines.

23 Glass meteorite from Billiton Island with curious markings. The smooth side is probably the one that struck the ground (approx. ¾ natural size)

Meganthropus and his Contemporaries

SHORTLY AFTER THE discovery of the second *Pithecanthropus erectus* skull, the problem of the Modjokerto child was solved. At the end of 1939, only a week before I was due to leave for Peking, Rusman, another faithful collector at Sangiran, sent

me a thickly encrusted upper jaw; and the remaining cranial fragments that were found reached me a few months later in Peking. We were very lucky to have all the pieces together there, for Chu, the head preparer at the Rockefeller Institute, who was accustomed to the hard limestone crusts of the *Sinanthropus* site, prepared our finds with incredible patience and skill.



24 Fragment of upper jaw of *Pithecanthropus modjokertensis*. Left, the state of the original; right, the reconstruction. Note the definite gap between canines and incisors (½ natural size)

We ended up with the major portion of a thick, coarse skull, of which only the frontal section and the upper part of the face were missing. Here again the signs of a violent death were unmistakable. The hind part had been crushed by a mighty blow, and in places the bones were not broken, but telescoped one over the other. Such a phenomenon is only possible with fresh bone: after death the bones rapidly lose their plasticity and simply fracture.

The upper jaw was also broken, but had to some extent retained its original shape. There were the same huge teeth we knew from the lower jaw we had originally ascribed to

Pithecanthropus erectus. Here again the relative size of the teeth differed from that of modern man. The second upper molar proved larger than the first, a feature normally characteristic of apes. The canine was not strikingly large, but it stood out above the rest of the teeth, and was worn down both at the front and back, so that it had a pointed, chisel-shaped crown. But the most remarkable feature of the jaw was a gap between the eye-teeth and the two outer incisors, a gap of 4 mm. on both sides of the jaw.

This space is known to anthropologists as the "simian diastema", although it occurs in all animals with large canines. When the jaws are closed the point of the big lower canine fits into the gap—otherwise the animal would not be able to shut its mouth.

It was the first time such a primitive characteristic had been observed in a fossil man—for the structure of the nasal aperture and the region round the ear left no doubt that the skull was human. Modern man, and all recorded upper jaws of fossil man, had always shown a continuous row of molars, canines and incisors, unlike the apes. Many anatomists went so far as to see in this an essential distinction between man and the apes. And now this theory was exploded. It was very much the same thing as had happened with the famous intermaxillary bone, which is clearly visible in practically all animals, but has grown firmly together with the rest of the upper jaw in man, and is therefore no longer distinguishable. At the end of the eighteenth century the Dutch anatomist Peter Camper saw in this a fundamental divergence between man and the apes, while the great Goethe took a particular interest in the intermaxillary bone, because he was firmly convinced that there could be no essential difference between man and the other mammals as regards the structure of the skull.

The extent to which man's dentition, with its almost smooth molars and the small eye-teeth, is original has long been a great point of controversy. There have always been anatomists who

doubted the connexion between man and the anthropoid apes or put the division of the two groups very far back in the geological past. And since a flat crown-relief and small canines are in truth primitive (but naturally only if they are original), these anatomists labelled man a primitive form that had little or nothing to do with the specialized apes with their complicated molars and large canines.

One of the few palaeontological laws states that primitive, older forms are generally smaller than their specialized descendants. If modern man's dentition is assumed to be primitive, then fossil man's dentition must have been similarly constructed and smaller. Many anthropologists who supported this view assumed that the living pygmies represented the most primitive human type, and they expected that fossil man would prove to have been more or less a pygmy.

The new finds did not in the least bear out this theoretical conception. The Neanderthaler had large, complicated teeth, and Heidelberg man, though his dentition was not essentially different from that of modern man, had an enormous, massive jaw. This was enough for many anthropologists to dismiss these two types of primitive man as "collateral forms" and exclude them from the family tree of modern man. And now every new find of fossil man turned out to have a large, complex dentition. Peking man showed a singular, extremely intricate crown-relief, but at least his dental arch was still human. Now here was the new *Pithecanthropus* possessing not only much too large and complicated teeth, but also a pointed canine and even a simian diastema. Had we up to now discovered only collateral branches of the human family tree? This is highly improbable, and a glance at the new finds clearly shows that the old hypotheses are no longer tenable.

Even in modern man there are still certain indications that he once possessed a much more powerful canine. They can only be observed in the milk teeth, and some time back Professor Remane of Kiel, after detailed study of the dentition

of children, came to the conclusion that the modern dentition must have been preceded by one with very much larger canines. His findings did not receive the attention they merited, however. The new discovery showed us that he was right.

The idea that there is something bestial about large canines is a typically European conception. Amongst many primitive peoples they are a proof of vigour and strength, and above all a sign of demonic powers. Many South and Central American demonic figures are given highly developed canines, and the same is true of South-East Asia. I am thinking here of the temple guardians of Siam, the *raksasas* of Java and Bali and the demons, the *butos*, of which there are both good and evil ones. Javanese dancing girls when playing the part of demons paint huge canines on their faces, and the wicked witch Rangda on Bali has enormous tusks and a fiery tongue that hangs down to her belly. The New Guinea Papuans imitate canines by inserting pigs' tusks in their noses (sometimes they are *ersatz* tusks made of shell). And the magnificent spirals which the Maori warriors of New Zealand used formerly to tattoo on their cheeks were in all probability a fanciful elaboration of symbolic canine teeth.

It may be assumed that man's earliest forebears, who originally lived in the tropics, fed mainly on fruit, as the great apes do today. That they could not have been good vegetarians without big, sharp canines will be evident to anyone who has been in the tropics. For tropical fruits are distinguished by their especially thick rinds, perhaps as a protection against the numerous insects. The orang-utan, living peacefully in the trees, has few natural enemies: he uses his large canines for opening the thick-skinned durian fruit as well as in self-defence—and it is a moot point which of these uses is primary and which is secondary.

During our comparative studies at Peking we could not quite agree whether the new *Pithecanthropus* skull represented a *Pithecanthropus erectus* or a new type. Weidenreich pointed

to the marked sexual divergencies between the male and female skulls of Peking man and believed that the 1937 skull belonged to a female specimen of *Pithecanthropus erectus* (as also the Trinil skull), while the new skull might be that of a powerful male individual of the same species. As we were of different opinions, we omitted any reference to a species from our joint description of the new discoveries, calling all the *Pithecanthropus* finds so far known simply *Pithecanthropus*. The Trinil skull was designated *Pithecanthropus I*, the first skull from Sangiran *Pithecanthropus II*, the small skull-fragment of 1938 *Pithecanthropus III*, and the large new skull *Pithecanthropus IV*.

On my return to Java I went as quickly as possible to Sangiran and got Rusman to show me the spot at which the latest cranium had been found. It unquestionably lay in the topmost layer of black clay and therefore belonged to an older horizon than the two skulls found earlier. Now, the black clay is coeval with the Djetis levels of East Java, from which our "*Homo*" *modjokertensis* came, and it became clear that this must be an adult skull of the same group. Stratigraphic differences had now been added to the morphological differences that distinguished this group from *Pithecanthropus erectus*. That it must be a *Pithecanthropus*, and a more primitive *Pithecanthropus* than the *erectus*, was evident; at a pinch one might even claim that here was a new genus, because of its extraordinarily primitive dentition. I therefore described the skull as *Pithecanthropus modjokertensis*.

During the war Weidenreich, in New York, once more compared the plaster cast of the skull with his *Sinanthropus* finds and also came, independently of myself, to the conclusion that the skull could not belong to *erectus*. He coined the new name *Pithecanthropus robustus* and believed that this new form also came from the Trinil levels. The name *modjokertensis*, however, had already been coined in 1936, and for this reason alone had priority over *robustus*, which was employed for the first time in 1945. The fact that Weidenreich used the name

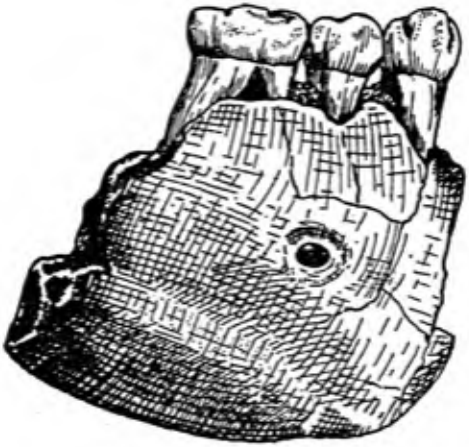
robustus in a large number of popular works, while the same find is described in my books as *modjokertensis*, has unfortunately caused some confusion.

The dentition of the new *Pithecanthropus* was much larger than that of modern man and even surpassed the jaw of Peking man. Did men exist with even larger jaws? The problem had cropped up for the first time when we discovered the huge teeth of *Gigantopithecus* in the Chinese chemist shops.

In Sangiran we often came across the large, heavily wrinkled, and therefore easily recognizable teeth of a fossil orang-utan that no longer occurs in Java. We also found other large teeth that looked much more like human teeth; nevertheless, it always seemed doubtful to me whether humans with such enormous jaws could really have existed. The first time one of my workmen sent me at Bandung the fragment of a gigantic lower jaw was in spring 1941, during the war. This jaw had been found not far from the site of the *modjokertensis* skull and in the same level. It was the size of a gorilla's jaw, and still contained three teeth—the first molar and the two premolars. The eye-tooth had unfortunately fallen out, but the alveolus was still in place and proved that the latter must have been relatively small. The premolars resembled those of Peking man, and the first premolar did not show the specialization caused in all apes by the large upper canine. There could be no doubt that this massive jaw was human. For at least a week I carried it about in my trouser-pocket, looking at it again and again with critical eyes to make sure that I was not mistaken. In spite of its size, which seemed much too great for a human jaw, everything about it was human. The second premolar had only one root, as befitted a human (in apes this tooth has two roots), and on the inside of the jaw behind the chin there was a tiny protuberance that would have delighted the heart of any anthropologist.

This was the rudimentary beginning of the so-called *spina mentalis*. To this spine are attached certain tongue muscles that

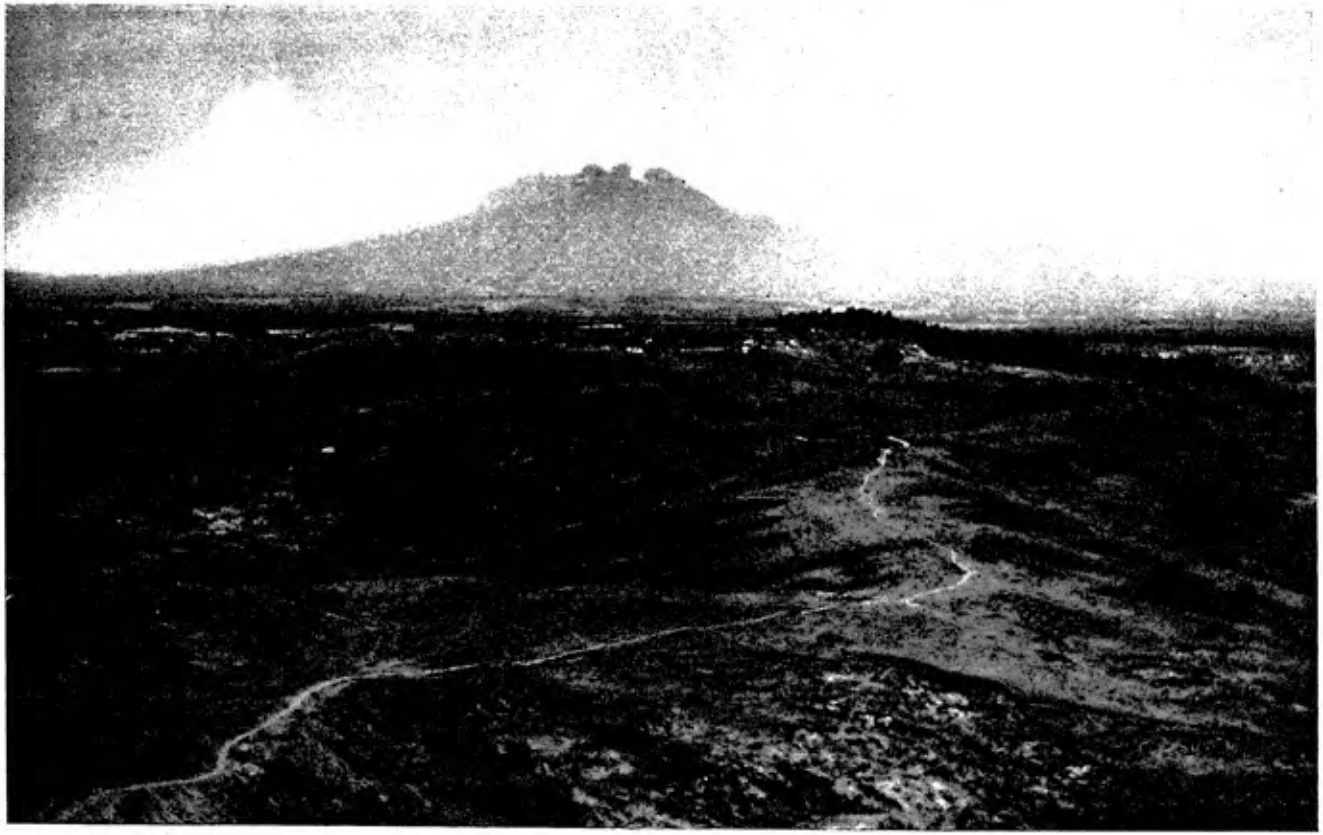
are required for moving the tongue at will and are indispensable in producing articulate sounds and hence articulate speech. Anglo-Saxon anthropologists frequently refer to this little outgrowth of bone as the *tuberculum geniale*. No ape possesses such a tubercle; it is characteristic of man alone. In rare



25 Fragment of lower jaw of *Meganthropus* (natural size)

cases it is lacking from relics of modern man, because it was only cartilaginous and has therefore not been preserved. We can already observe it in the jaw of Heidelberg man, and it is also present in Peking man. This area is unfortunately missing from our *Pithecanthropus* jaw, but we must assume the tubercle's existence—a fair development of the speech centre, which is localized in the third left frontal convolution, is clearly visible in the brain-cast.

The presence of the *spina mentalis* is quite sufficient positively to classify this jaw as human. We named this new primitive



The landscape of Sangiran, Central Java. The terraced rice fields (*left*) lie on the clays of the Djetis levels; the slopes consist of sandstones and tufas of the Trinil formation. In the background, the volcano Lawu

Lower jaw of modern man (*left*), *Meganthropus* (reconstruction), and gorilla

The reconstructed upper jaw of *Pithecanthropus modjokertensis* (*centre*), compared with the upper jaw of modern man (*right*) with the continuous dental arcade, and that of a gorilla (*left*) with "simian diastema" (marked by arrow)

man *Meganthropus palaeojavanicus*, "The Great Man of Ancient Java".

As already stated, this jaw is certainly as large as that of an adult gorilla, from which it is immediately distinguished by the absence of the large canines. Whether *Meganthropus* himself was as large as a gorilla we do not know, since no further bones have been found. But it is not impossible. There are some anatomists who deny that such gigantic jaws necessarily imply gigantic stature: in domestic animals disharmonies between size of body and size of jaw have been observed. In my view there are no grounds for assuming anything of the sort in man, for no comparable case is known in the whole group of the Primates. Among anthropoid apes the little chimpanzee has the smallest and the huge gorilla the largest jaw, while the orang-utan comes in between. We are therefore justified in describing *Meganthropus* as the Java giant, as has already been done in America. How big he was is difficult to estimate; some credit him with a height of 8 feet 3 inches, but any reliable calculation of his height must await the discovery of some part of the thigh or shank.

The China giant, *Gigantopithecus*, must have been larger still. Dubois was always very interested in the ratio between body-weight and brain-weight, or size of skull. When I showed him the huge teeth on the occasion of my visit to Haarlem in 1936, he astounded me by exclaiming: "*Gigantopithecus* must have weighed at least 56 stone. But that's impossible." Then he looked at the tooth more closely, with a great deal of head-shaking, and said nothing. In popular reconstructions *Gigantopithecus* has been given a height of 11 feet 6 inches, but this naturally is pure fancy.

In 1939 we found another fragment of jaw in the black clay at Sangiran which must have belonged to a larger mandible than that of *Pithecanthropus modjokertensis*. There were some other striking divergencies too: the section through the chin region was different and the crowns of the teeth showed more

folds. The jaw differed from that of the 1941 *Meganthropus*, but my guess was that it belonged to a female and the large jaw to a male.

War with Japan was already in the air. Since people in Java had not sufficient interest in relics of primitive man to put them in a place of safety in the event of trouble, I sent plaster casts of the new finds to Professor Weidenreich in New York—at the very last minute, as it turned out—so that these, at least, should be preserved if the worst came to the worst. Weidenreich immediately recognized the importance of the new finds. The rumour went round that I had been drowned; and as he did not wish to wait any longer, he described our primitive men on the basis of the casts. Since these did not show every detail, and as Weidenreich had no knowledge of the conditions under which the pieces were unearthed, his conclusions were only partially correct. He could not do much with the aforementioned jaw-fragment—indeed, he even supposed it to belong to an aberrant ape. Not until later, when I brought the original to New York and we were able to prepare it better, could I demonstrate to him that the jaw was human, while he convinced me that it was too different from *Meganthropus* to belong to the same species. Since we had both been mistaken I named this new form of primitive man *Pithecanthropus dubius*.

The presence of various types of primitive man side by side in the black clays is very remarkable. From our observations it appears unlikely that they came from different strata and therefore belonged to different periods. We must not lose sight of the fact that, as we have already seen, the Malay fauna is composed of diverse elements, namely those that were originally Indian and those that were originally Chinese. Of these the former are the older and certainly go back to the Tertiary; while the Chinese, with the orang-utan and the tapir, migrated to Java just at the beginning of the Pleistocene. In all probability the two zones already possessed their own form of primitive man, and these two forms met in Java.

The discovery of giant forms of man is of tremendous importance to our knowledge of the human story. We must bear in mind that they date from the Early Pleistocene and are therefore older than Peking man or Heidelberg man, to say nothing of the Neanderthaler. These, in fact, are the oldest known human remains. Their age may be estimated at a minimum of 500,000 years.

If we compare the various jaws of the primitive man of the Pleistocene, it is manifest that our dentition has become very much smaller since then. This conclusion positively forces itself upon us. Weidenreich has expounded his ideas on this point at length in various papers, and notably in his popular book, *Apes, Giants and Men*. He regards *Gigantopithecus* as more or less the initial form and then assumes a Chinese and a Javanese line of development. He sees in Peking man the direct progenitor of the Mongols, in *Pithecanthropus* the forerunner of Solo man, and in the latter the primordial form of Wadjak man and of the Australian aborigines. His views have found little favour with anthropologists: we have already seen that *Gigantopithecus* is neither geologically old enough nor is his dentition sufficiently primitive for him to have been the parent of the race.

During the war our investigations at Sangiran had to be abruptly terminated, and by the end of December 1941 all activity had ceased. The Japanese occupied Java, and all the finds so far described had to be placed under their supervision in the Geological Survey's big safe. We very circumspectly substituted plaster casts for some of the originals. The casts were extremely well made and to lay eyes almost indistinguishable from the originals. We had mixed finely ground brick dust with the plaster of Paris, so that even in the event of injury the break would remain nicely dark, as in a genuine fossil. We switched the skulls, so that if the contents of the safe should one day vanish eastwards a few original pieces, at least, would remain in the country. The new finds, which had not yet been described and were unknown, were housed with neutral friends

—a Swiss geologist and a Swedish journalist. Showing great temerity, my wife retained the precious upper jaw. All the finds survived the war. Our Swedish friend, fearing a house search one day, put my collection of teeth—which included those of *Pithecanthropus* and *Gigantopithecus*—in large milk bottles and buried them by night in his garden.

Not until after the war did we learn that our American friends had made a last-minute proposal that the original finds should be moved to America; but their offer had not been accepted.

The end of the war found me in a Japanese prisoner-of-war camp on Java. I was grateful to find my little family in good health, and happy that all our material had survived the war. Only one of the Solo skulls had been carried off to Japan as a birthday present for the Emperor; it survived the air raids and was found again after the war. We had informed the American Intelligence Service of our loss, and one day, when I was working in New York, a young officer appeared unexpectedly and with a polite bow handed me back the skull. So today the whole Solo family is once more complete.

The situation in Java after the war was such that it was not easy to get news to Weidenreich. He was glad to hear from us, since we (and the finds) had been given up for lost. At his suggestion the Rockefeller Foundation and the Viking Fund (now the Wenner-Gren Foundation) generously invited us to New York; the magnificent American Museum of Natural History hospitably offered us a work-room. In September 1946 we arrived in New York, where Weidenreich was anxiously awaiting us. From him we heard for the first time that all the Peking man material had been lost. I now began to realize how lucky we had been with our Javanese finds.

I worked with Weidenreich for almost another year and a half—he on the Solo skulls, I on the *Pithecanthropus* material—until I returned to Holland in 1948 to occupy a chair in palaeontology at the University of Utrecht. Unfortunately it

was not granted to Weidenreich to conclude his work: he died unexpectedly in 1949. The disappearance of his *Sinanthropus* material, which could not be traced in spite of the efforts of many official bodies and must be regarded as irretrievably lost, had upset him more than we guessed. His intimate knowledge of nearly all the important finds of fossil man in our time made him an authority of the first rank, and by his detailed, careful and thorough description of the *Sinanthropus* material he performed a lasting service to our knowledge of fossil man.

The Japanese occupation of Java had forced us to drop our work in Sangiran at the beginning of 1942. Not until ten years later was Dr Pieter Marks, a lecturer at the University of Indonesia in Bandung, able to visit this promising fossil locality. He found more than 14 cwt. of fossils waiting, which had been carefully put aside for us through all these years—and once more a human jaw! This was a *Meganthropus* mandible with an almost complete dental arcade, unfortunately somewhat crushed and with only one tooth. The jaw is just as massive as the first one of 1941 and proves that *Meganthropus* is unquestionably a type on its own, and not merely an aberrant individual. The new find exhibits, even more clearly than the first fragment, a likeness to the South African half-men, the australopithecines or "Southern apes", of which more will be said later.

The Stones of Patjitan

MEGANTHROPUS and *Pithecanthropus modjokertensis* were probably unacquainted with tools; worked flakes, chipped from larger fragments, are known to us from *Pithecanthropus erectus*, and from Solo man only stone balls, a few bone implements, and several irregularly fashioned sharp stones. But we also know something else about Java. Because man began at a very early stage to make his implements from the hardest stones he could find, so that in many strata so lixiviated that they are

devoid of all bones and all organic substance stone implements have been preserved, we know of man's existence in areas where no human fossil has ever been, or is ever likely to be, found. In India, particularly in the Madras district, large masses of river-clay and sands have been transformed by tropical weathering into tacky red clay called "laterite", yet implements of hard quartzite are by no means rare in these strata.

In Java it was no easy task for man to find suitable material for making his implements. The most prevalent kinds of stone —limestone and volcanic stone—are virtually useless for this purpose; but in the hinterland of the great Lawu volcano hot springs of water with a high silicic acid content have appeared in connexion with volcanic eruptions. The limestone has thus been largely "silicified", that is to say, turned into a hard, flint-like substance which splinters easily and gives very sharp edges. This stone is ideal for implement-making and was indeed long used for this purpose. Its limestone origin is in many instances easy to recognize, as the fossils—chiefly corals and shells—present in the stone are likewise silicified.

At some places in West Java the springs containing silicic acid have filled fissures with successive thin layers of this substance. Hence the formation of agate where there is differently coloured stratification, and of chalcedony in the absence of such layers but where various centres of growth and impurities have produced a splendid cloudy effect. Chalcedony is usually whitish, but may where there is an admixture of iron be yellow or even dark red.

As has long been known, large quantities of stone implements from the Late Stone Age are to be found in the Punung and Patjitan district; but it was only in 1933, during a joint reconnoitring expedition with Dr Tweedie of the Raffles Museum, Singapore, that we discovered the first implements of a much more primitive type, namely, hand-axes. These axes, of which more will be heard later, are large implements and were always worked on two sides. The most perfect of

them are almond-shaped with a sharp cutting edge all round: in the more primitive form they are thicker and the underside is not worked. They vary in size from approximately 10 to 30 cm. Such axes were long known from Europe, Africa and India, but it was surprising to find them in Java.

The Punung region lies in the so-called Southern Range, the Gunung Kidul, and more particularly in the area called

26 Primitive chopper and hand-axe from Punung, Central Java

Gunung Sewu, the Thousand Mountains, after the thousands of small limestone mountains which give the landscape such a characteristic aspect. The Southern Range is for the most part barren, as the water runs away so swiftly into the limestone fissures that it is too arid here for much vegetation to grow. The area is also sparsely populated because the Javanese do not care for districts where they cannot lay out irrigated rice-fields. In prehistoric times, however, this area lay much lower; we were fortunate enough to find several fissure-fillings near Punung containing numerous molars of pig, ox and tapir, and this points to much moister conditions. At that time, too, there were large rivers which must have left behind substantial sand and gravel deposits. Later, however, the whole of this

limestone plateau disappeared and the water-level sank. Heavy erosion took place, causing the disappearance in their turn of the majority of these deposits. There is hardly anything left of the finer sand and gravel masses, but large stone implements made of hard material remained in the river-beds.

It was in crossing a practically waterless river-bed during the dry season that, to our great astonishment, we found a hand-

27 Hand-axe, advanced type, Punung, Central Java

axe. Minute investigation at that spot, with the assistance of numerous young people from a nearby *kampong*, yielded three chestfuls of stone implements within a few hours—the beginnings of an enormous collection made in the course of several years in the Punung district. Typologically, these hand-axes must originate from strata of different ages, but it was not possible to find a spot in the immediate surroundings where there was any recognizable stratification. Most of the implements are therefore, as we term it, in secondary interment; which unfortunately made unravelling of the various geological culture horizons indicated by the hand-axes impossible.

The most primitive forms are ordinary round river-stones with a sharp cutting edge imparted to them with a few strokes. The hand-axes are very clumsy and the butt end is left

untouched so that such "hand-axes" can indeed be effectually grasped in the hand. Others are finer in shape, thinner and with a continuous cutting edge. The butt end of these must have been covered with some material such as resin or clay, as is still done by the Australians with their stone knives. Perhaps these hand-axes were set in a handle, of which naturally nothing remains.

28 Big rostrocarinate implement (scraper?) from Punung, Central Java

The discovery of this hand-axe culture brought Java out of its isolation and so facilitates comparison with the hand-axe culture of other lands. Unfortunately, not one of our sites of fossil mammals in Central and East Java has produced even a single hand-axe, so that it is still somewhat difficult to place this culture correctly in geological chronology. Most probably it should be placed between the strata containing *Pithecanthropus erectus* and the more recent geological horizon containing Solo man. It is known that the latest hand-axes in Europe were made before the last Ice Age began. After this, an entirely new culture arose in which implements were made from flakes, whilst in the more recent strata the very varied range of instruments of *Homo sapiens* is to be found. In Africa, the course of

development followed roughly the same lines, but in Java such more recent culture-levels from the Ice Age are so far lacking. It is therefore possible that the hand-axe period lasted somewhat longer, as in some parts of Central Africa. In Patjitan large implements resembling hand-axes are to be found with one absolutely flat face. This type has become well known from more recent deposits in Central Africa, but some other implements characteristic of such strata are not encountered in Java. And yet there is probably some connexion between them, for, as we have already seen, there is also a possible anthropological link between African fossil humans of the Rhodesia and Saldanha man type and our Solo man. Here we are confronted by one of the greatest problems of Javanese prehistory as yet unsolved.

Patjitan has in the space of a few years produced an enormous amount of material in the shape of hand-axes. We ourselves had more than fifty chestfuls in Bandung, most of which, deposited later in Djakarta Museum, have also unfortunately been lost. At times we found so many worked stone axes that every stone of larger proportions appeared to be an implement. So much so that I began to doubt my own judgment, and it was not until later, when I saw the African sites with their inconceivable wealth of artefacts, that I realized I had not been so overwrought as I imagined! The inhabitants of Patjitan were rather superstitiously timid about collecting these curiously shaped stones; so, to save face, my collector said that we needed them for medicinal purposes. . . .

Very cautiously, drawing comparisons with hand-axe cultures known in Europe and elsewhere, we are now endeavouring to unravel the various culture-levels typologically. The bulk of this work is being carried out by our friend Professor H. Movius of Harvard University—who had already visited us in Java, where he also saw the sites—together with the young prehistorian H. R. van Heekeren, who is still enthusiastically operating in Java.

The Giant and the Teeth of the Lightning

WE HAVE ALREADY become acquainted with various fossil humans from Java, and will now try to bridge the gap between them and the modern population of this beautiful island. Indeed, the various types among our ancestors, whose acquaintance we have made in this book, did not immediately follow upon one another, and between the different finds there may lie wide geological gaps. We do not know which forms come from outside—certainly the oldest, but which are these?—and which from Java itself. We are chary of drawing "genealogical lines". There was thought to be one such continuous line from *Pithecanthropus* through Solo man and *Homo wadjakensis* to the Australian, but when one speculates on the migrations and racial intermingling that must have taken place in the past few thousand years in Java this becomes more conjectural.

What do we know of the history of the modern man of Java, of the advent of *Homo sapiens*? In Europe he put in an appearance a good 60,000 years ago, when the last Ice Age was already past its zenith and Neanderthal man had disappeared.

We do not know exactly how it happened in South-East Asia. In any event, Neanderthal or closely analogous forms are known neither from Australia nor from the islands east of Java. We may therefore assume that they were not yet able to build ships or rafts, nor travel any long distances by sea. Seeing that Java was continuously connected with the mainland of Asia, none of the fossil humans of Java ever needed a conveyance to reach this place.

Probably the oldest form representative of our type in Java is the Wadjak man mentioned earlier, who was found in a rock fissure in the Wadjak marbles near Tulungagung on the south coast of Java in 1889. This find was, as we have already seen, the reason for young Dubois going to Java from Sumatra.

Dubois then took the Wadjak finds to Europe, but did not work on them until 1920.

The remains of two Wadjak skulls are known to us; the exact geological age is unknown, but is probably not great. It is highly improbable that the skulls are Pleistocene, that is to say, from the end of the Ice Age, as Dubois thought. There are still a few neck vertebrae attached to one skull, from which it may be inferred that we are dealing with a burial. The site has unfortunately yielded no implements.

Wadjak man is well supplied with grey matter (1,550 c.cm.) and has no supra-orbital ridge. The curve of the jaw is remarkably large, but the dentition itself is not primitive. According to Dubois such a big jaw proves that *Homo wadjakensis* ate more animal food than the Neanderthal who, according to him, must have been a vegetarian. This all seems highly improbable, because it must have been easier for Neanderthal man during the Ice Age in Europe to obtain flesh than to come by other food, whereas Wadjak man lived in surroundings where he had fresh fruit at his disposal the whole year round.

Dubois has already described Wadjak man as a "Proto-Australian", and it is true that in 1940 a skull of apparently the same type was found at Keilor, just outside Melbourne, in Australia.

There are grounds for supposing that the Australians, in whom we think to recognize Europoid elements also, must originally have come from Asia. Australoid skulls are said to have been found in India, but so far, unfortunately, no description of them has been given. The route followed by the Australians to their present abode is indicated not only by our finds on Java, but by skulls from New Guinea.

For nearly fifty years Wadjak man, discovered by accident, was the only known "prehistoric" inhabitant of Java.

The remains of ancient Hindu culture, with its temples and inscriptions, reliefs, statues of gold, silver, bronze and stone—perfect in symmetry, a symphony in beauty of form, springing

from a profound mystic realm of thought, so fascinated the archaeologist at work in Java that he hardly had an eye for other problems. As late as 1920 Van Eerde writes of the "total obscurity of Indonesian prehistory". It is due to one man, Dr Pieter Vincent Van Stein Callenfels, that it did not remain so. Stein, also called "Tuwan Sétan" or "Tuwan Raksasa" by his Javanese friends (a *raksasa* is, as we have already seen, a giant of Hindu mythology, of fearsome exterior and large eye-teeth) and known among the Europeans usually as "Ivan the Terrible", was already a legendary figure in his lifetime, and in my day undoubtedly the best-known European not only in Indonesia but in the whole of South-East Asia. More than six feet tall and weighing a good 24 stone, he would have made a striking figure even in Europe: among the slightly built Indonesians he was a giant! His appearance was accentuated by his black beard, which was already beginning to turn grey when we first met; by his long hair—except in special circumstances, he had his hair cut only once a year, preferably on the date of the Battle of Waterloo—by his deep and very sonorous voice, and particularly by his keen and at the same time merry eyes, for Stein was fond of a joke. With a poker-face he would talk the greatest imaginable nonsense, just to see how much he could get people to believe, and he could come out with pungent and witty repartee. Stories about him are legion!

It is only natural that anyone of Stein's size must have an unusually large appetite. If he was going on a journey he would bring for rations for four persons, which he himself calmly devoured. In Manila he once ate, for a wager, everything on the extensive menu, first from top to bottom and then from bottom to top. Twenty bottles of beer and two of Hollands gin a day were not too much for him. I still have a bulletin of the *Preanger-Bode* in Bandung issued on May 19, 1933, in which it is stated that Mr Van Stein Callenfels confirms that the beer of the Archipel Brouwerij of Batavia is the best in South-East Asia! Everyone understood the joke and laughed,

no one taking offence. He had an innate horror of total abstainers. At the time of the Prohibition he was conversing with an American colleague on the subject of human races. "I only know two," said Stein. "And what are they?" inquired the American, interested. "Very simple," replied Stein, "one drinks beer and the other whisky." "Which do I belong to, then?" the American wanted to know. Whereupon Stein said very affably, "My good friend, I am talking of anthropology, not zoology!"

Stein possessed incredible powers of concentration. We once put him to the test. He could simultaneously read a book, carry on a conversation and overhear a second conversation. He was a genius at languages and his knowledge of Javanese particularly was so thorough that he could tell from a man's dialect which part he came from. He was a specialist in Sanskrit and knew numerous old Javanese tales and legends by heart, narrating them like an accomplished actor. High-placed Javanese were pleased to invite him to stay, and he would sit of an evening in the big *pendopo*—an open structure with only a roof—surrounded by the whole village, telling of princes and *raksasas*.

Although Stein also began by studying Hindu archaeology, he gave this up to devote himself to the much less spectacular subject of prehistory. He not only carried out excavations in Java, but also investigated shell-hills in Sumatra and the Malay peninsula and made a penetrating study of the Toalas, a primitive tribe in the Celebes. Stein's collections are for the most part in Djakarta Museum, but only a fraction of his scientific work has been published in professional periodicals. With his huge thirst, Stein needed money, and so many reports of his were published in the papers, especially the *Surabaische Handelsblad*.

Stein did pioneer work in the archipelago. For a long time he had to work alone, and it was not until later that Dr A. N. J. Th. à Th. van der Hoop, geographer and aviator,

attached to the Prehistoric Department of Djakarta Museum, came to join him, also as—shortly before the war—did Dr W. Willems. In 1938 we saw Stein for the last time at a congress in Singapore, where he was working at the Raffles Museum. He was at the time suffering from a huge tumour on his back (he proudly sent us a photo, his last, of this) which would not heal and as a result of which he died on April 27 at Colombo, aged only fifty-four. His heart could stand the strain no longer.

29 Bone spatulae, Sampung cave, Central Java

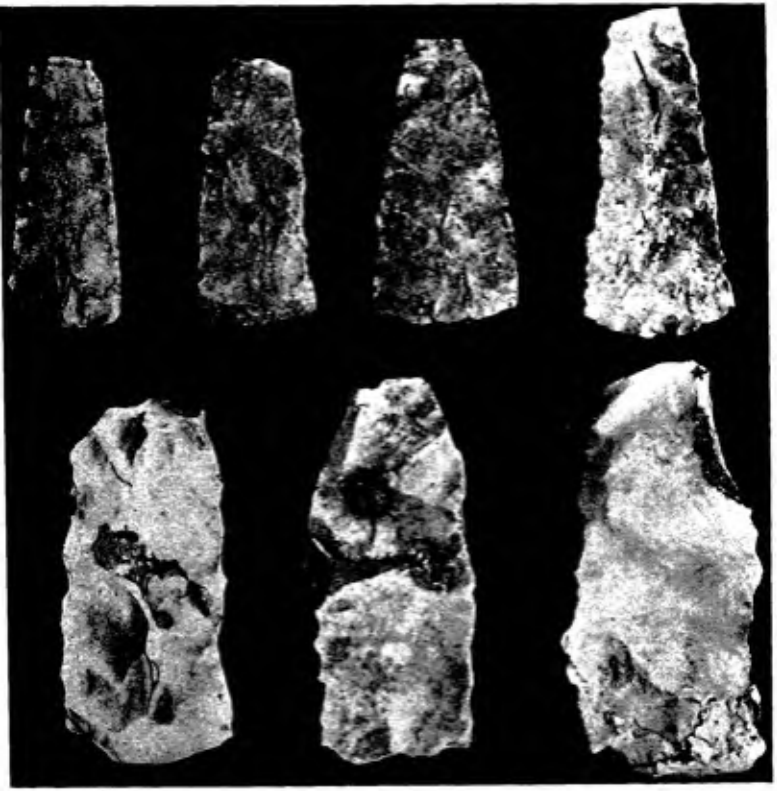
When the manager of his hotel found him in his room, his wallet and the gold watch presented personally to him by the King of Siam had already disappeared. . . .

The first site to be further considered here is the Guwa Lawa grotto near Sampung in Madiun (Central Java). L. C. J. Van Es, one of our colleagues in Bandung who was very interested in prehistory, had found a grotto here in January 1926 under projecting rocks, and had begun to excavate it. He had other more important work to do, however, and passed on this site to Stein, who worked on it from 1928 to 1930. It is said that Stein first dug a new trial pit and only when this was deep enough to keep beer reasonably cool did he begin on the actual work.

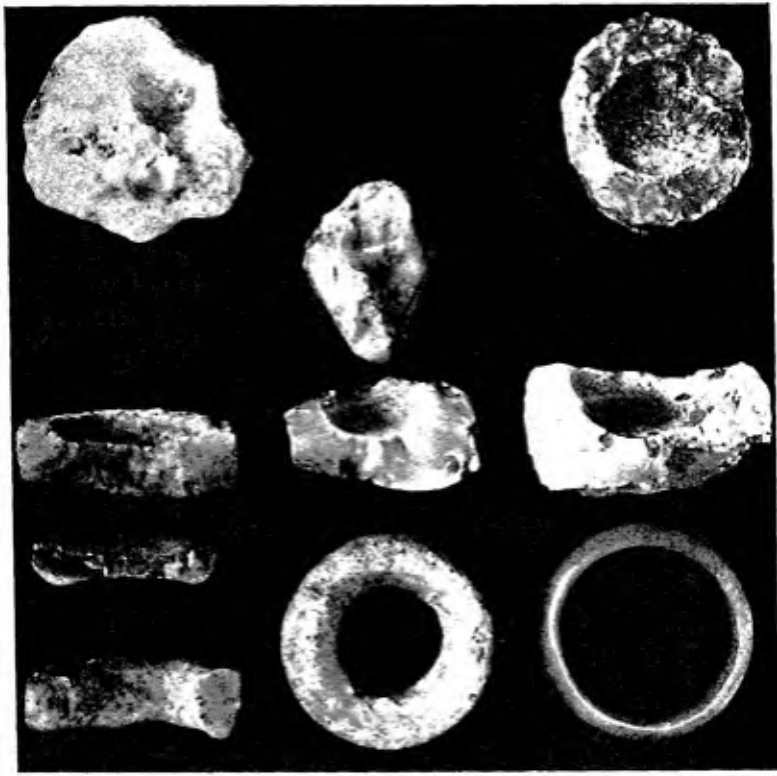
Stein found three different strata which it is difficult to delimit one from the other. The top stratum, besides several

modern objects of recent date, contained a few stone axes. According to Stein, this stratum belongs to the Late Neolithic period. The Neolithic or Late Stone Age is generally characterized by ground stone implements and earthenware. In Europe the Neolithic period precedes the Bronze Age: in New Guinea the Papuans still live in the Neolithic. In Sampung, beneath this stratum, there is one containing many bone implements—flat and pointed spatulas, mostly made from the horns of the *kidang*, a small deer-like animal of Java, as well as awls and harpoon tips. In the lowest stratum, to our astonishment, there came to light stone arrow-heads, most of them with a concave underside forming a short barbed hook. In these strata, rubbing-stones and potsherds were also found, so that the whole complex must be ascribed to the Neolithic period. The lowest stratum rests partially on old river and swamp deposits.

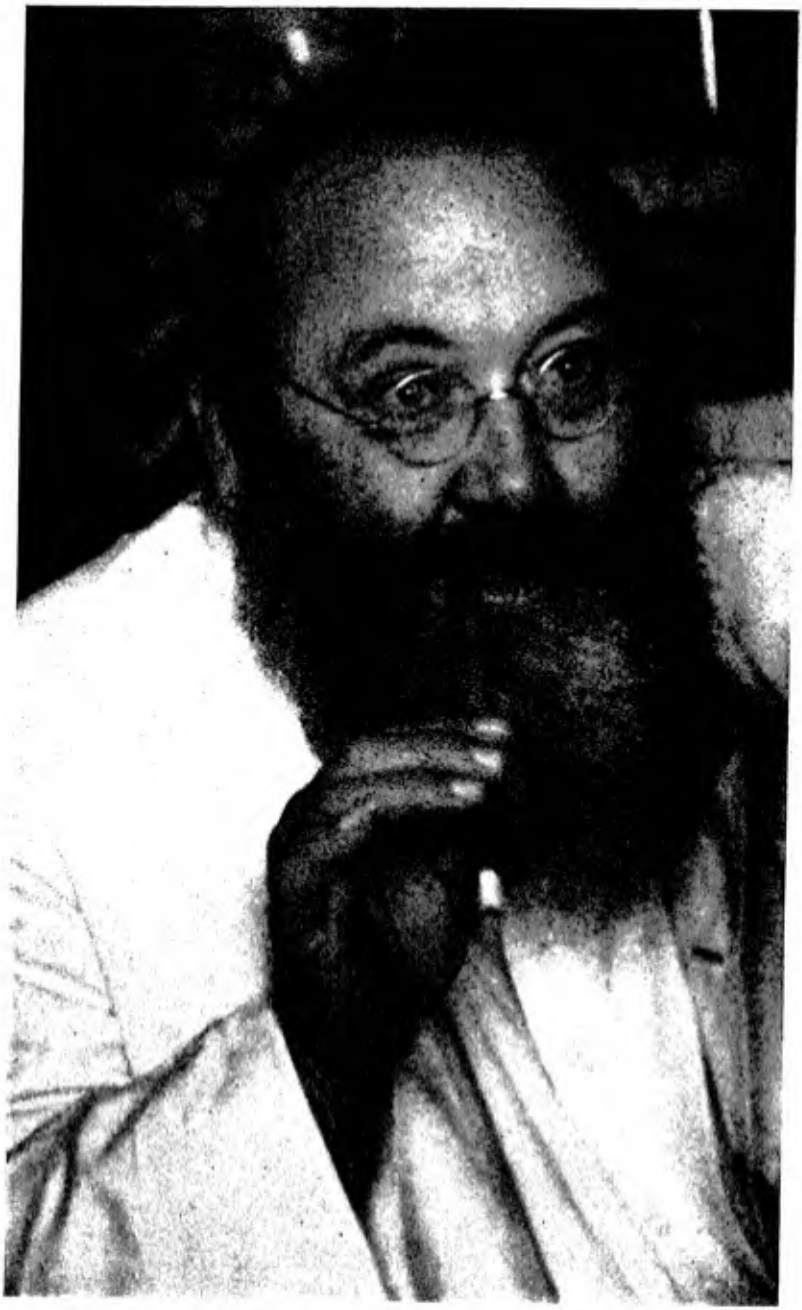
In all strata there were numerous very rough stone implements and innumerable crushed bones. Most of these are of the banteng, the Javanese water-deer, the *kidang* mentioned above, pig and rhinoceros. Remains of other kinds of animals are more rare, but amongst them are several no longer extant in Java. There is a hare corresponding to a species from India. This hare, it is true, still occurs in the neighbourhood of Bogor, where the former Governor-General's palace stood, and for this reason it used to be believed that it was brought to Java from India in days gone by, like the Indian axis deer, which are still to be seen in the palace park. It now appears that our hare arrived in Java earlier. A piece of the jaw of a clouded leopard was also found; this leopard still exists in Sumatra but is extinct in Java. The same applies to the Sumatra elephant. Prehistoric remains of these have been found on the tin islands of Bangka and Billiton, so that there is reason to suppose that these two islands formed a bridge to the Malay peninsula. The most interesting animal of the Sampung fauna is, however, the *thamin*, the "brow-antlered deer" with the Latin name of



Stone axes in various stages of manufacture—so-called "blanks" from a Neolithic work-yard in the neighbourhood of Punung, Central Java



Stone bracelets from Karang Nungal, Western Java, in various stages of manufacture



Dr V. P. Van Stein Callenfels, the father of Indonesian prehistory

Rucervus eldi, a striking animal whose antlers curve elegantly to above the eyes, as in the reindeer. This deer still exists in North Malaya, Burma and Indo-China, but does not occur in Java either as a fossil or as a living animal. There must therefore have been a land-bridge at some time between the Ngandong period and the present, connecting Java with the mainland of Asia, a bridge which probably disappeared only a few thousand years ago.

Of the three culture horizons of Sampung, that containing the bone implements is certainly the most interesting. This culture is also known from other places in Java, such as Bodjonegoro, and from a grotto near Sitobondo excavated by H. R. Van Heekeren, as well as from the Malay peninsula and Indo-China. It may be assumed that this culture was formed by a population group other than that using the stone axes, and there is reason to suppose that this group must have been of Papuan type.

At Sampung several skulls have also been found; they were, however, in a bad state of preservation. These have been described by Professor E. B. Mijsberg, who noticed distinct dissimilarities from the Javanese and a resemblance to the primitive group of Veddas-Dravidas-Australians, to which the Papuan-Melanesians also belong. The Papuans at present inhabit New Guinea, the Melanesians the surrounding islands: the two groups are closely related. A striking characteristic is their coarse front and back teeth, which are sometimes larger than the maximum found among the Javanese.

These Papuan-Melanesoids are peculiarly distributed. At Chou K'ou Tien, near Peking, we find in the same hill which yielded remains of Peking man, grottoes with much more recent contents; and it is here that a skull has been recovered which, according to Weidenreich, shows distinct Melanesian features. This skull is believed to originate from the Ice Age, which would make it the oldest of this type. Farther south, Melanesian influences are to be detected in Indo-China, and one

30 Stone adzes from Java. Primitive types (*top*) and typical "quadrangular" adzes. *Right:* "pick" with triangular cross-section. The specimens at the bottom from Bandung, Western Java

of the most important finds was made by Stein in the Malay peninsula and likewise described by Mijsberg. This was a complete lower jaw found in a shell-hill at Guak Kepah in Welleslay Province, so large and wide and with such definite characteristics that it can immediately be compared with those of the New Caledonians (New Caledonia is an island southeast of New Guinea), who are regarded as an ancient Melanesian population group. Now, the New Caledonians use flat, round or oval stone disks as special symbols of dignity (sometimes made of a green jade-like material) with two holes pierced in them, the disks being tied to a handle with string. Furthermore,

such flat stone disks, likewise pierced with two holes, are also known from prehistoric sites in the Malay peninsula. There are grounds enough, therefore, for assuming that these New Caledonians also passed through the Malay peninsula on their way to their present abode. They must at that time already have possessed their characteristic physical peculiarities, as well as objects definitely characteristic of their culture.

Perhaps the Australoid population moved eastwards under pressure from this Papuan-Melanesoid wave, while the latter in their turn disappeared from Java before the advancing Malay peoples.

To revert to the Papuan-like people: the Papuans in general use stone axes with a lenticular or oval cross-section, the "*Walzenbeil*", in contrast to the typical Indonesian stone axe, which usually has a square cross-section and is accordingly also known as the square or oblong axe. This was taken to be a fundamental difference, and for this reason Stein always expected to encounter in Java, too, an older stratum containing axes of the Papuan type. However, this never happened: either the *Walzenbeil* was introduced into New Guinea from elsewhere (which is difficult to imagine) or this axe owes its origin to contact with Indonesians, but with a change in the original shape due to the difference in material. The Indonesian axes are mostly made of a kind of flint which splinters easily and in which angular forms can be produced without much difficulty by chipping and retouching; whereas the Papuans must have used very hard and tough stone which cannot be worked in this way and had to be ground, so that the form is naturally more rounded. There is a distinct resemblance between the most extreme forms—Indonesia and New Guinea —the only essential difference being that the former are angular and the latter are rounded off; such cultural contact is therefore very likely.

The diverse and at times very fascinating objects of art from New Guinea are possibly not a purely native product. The late

Professor F. Speiser, curator of the Ethnographical Museum at Basle and one of the greatest connoisseurs of the art of New Guinea, always attributed to certain art forms a strong influence from the east. This applies above all to the "korwar" style of West New Guinea, as well as to the remarkable "beak" style of the Sepik district. (The Sepik River flows into the sea about half-way along the north coast of New Guinea.) The human

31 Stone arrow-heads from Neolithic strata at Punung, Central Java (*left*), and fragments of stone bracelets from western Java. The bracelet at the top is made of chalcedony, that at the bottom, with rim, of green jasper

representations of this region have in many instances a remarkable beak-like nose. Speiser suspects this to be due to an influence that reached the Sepik area via Indonesia: he believes that this beak may be derived from the Indian god Ganesha's trunk. I personally consider this rather unlikely and am more inclined to attribute the beak to the influence of the Indonesian garuda (the garuda is a magic bird and the steed of the god Vishnu). Garuda masks are still widespread in Bali and Java. Moreover, a small mask design encountered in Java on the upper edge of the blade of a kris, near the hilt, shows a marked similarity to certain masks from the Sepik district.

To revert once more to Sampung: it has already been remarked that stone arrow-heads have been found in the lowest formation. It is a striking fact that these do not occur, as is usual in Europe, along with the axe, but apparently belong

to an older culture-level. Correspondingly, in the Punung region, with which we made acquaintance when discussing hand-axes, we invariably find separate workshops for arrow-heads and axes (first noticed by Stein) which were therefore never made together at the same spot.

The typology of the Javanese arrow-heads has never yet been properly sorted out. We know them on a convex, straight or concave base, made from a chipped-off flake and worked only along one edge or uniformly along both edges. In the most complicated type, only one side of each edge has been retouched.

The Javanese arrow-head constitutes a problem in itself, for the only directly comparable type occurs in Japan. Neither in Indo-China nor in the Malay peninsula has anything of the kind been found. The arrow-heads of Celebes are completely different, having either a tang, or being triangular with a serrated edge, which does not occur in Java. On the other hand, similar heads are known from Australia, where, partially set in a short wooden or bone shaft, they are used by Warda man as digging implements.

At present, widely different peoples and tribes inhabit the Greater Sunda Islands, and it was probably much the same during the Neolithic period, although the Australoids and Papuan-Melanesoids have now been driven out by the Malays. The Malays came in at least two great waves, first the Proto-Malays such as the Dyaks of Borneo, the Toradjas of Celebes and the Tenggerese of Java; and later the Deutero-Malays, to which group the Sundanese, Javanese and Madurese in Java belong.

But before, and perhaps simultaneously with, the Proto-Malays other peoples entered the archipelago, definite remains of whom have so far not been discovered in Java, but who had in all probability been there. I refer to the Pygmies, a small race with an average height of less than five feet, woolly hair and negroid features. They still exist in the interior of Luzon, the

largest of the Philippine Islands. I refer also to the small but smooth-haired Veddas, still to be found in their purest form in Ceylon, and to whom the Toalas of Celebes are probably related.

As we have already seen, stone axes of the "square" type have been found in the topmost strata of Guwa Lawa. Professor R. von Heine-Geldern, one of the greatest experts in the prehistory of South-East Asia, has drawn attention to the fact that in Asia the area of Indonesian languages and that of the prehistoric axe culture are practically identical. Although neither a language nor a culture need be intrinsically linked with a population group, we nevertheless have grounds for assuming that such axes were also made in Java by a Malay tribe.

Stone axes are known throughout Java as *gigi gledek* (teeth of the lightning) and as *batu guntur* (thunderbolts). It is remarkable how the present population refuses to regard them as utensils, attributing to these axes a supernatural origin. Strangely enough, it is the same with the prehistoric bronze axes found in West New Guinea round Lake Sentani, which are also regarded as magic objects.

Lightning is fancied as being a big animal concealed behind the clouds which bites trees, thereby losing its teeth. One is told in all seriousness over and over again that the axes were found in a tree-top, and even in the scientific catalogue of the National Ethnographical Museum at Leyden it is stated, under Javanese antiquities: "No. 2579, axe found at Malang in a *Ficus lucescens* in a rice-field." If a Javanese finds a stone axe, he will keep it with sedulous care. Occasionally a stone axe is also to be seen set in silver and worn as an amulet. In West Java, axes are immersed in water—the bigger the axe the better—and this water is then given to the animals to increase their strength. This is done particularly with rams, which are set to fight one another in the Sunda Islands. These ram fights are the occasion for heavy betting, as happens with cock-fighting in Bali.

As has already been noted, the Javanese stone axe usually has an oblong cross-section; rounded forms are rare and represent unfinished specimens. The most primitive forms, probably the oldest, are still somewhat irregular; then we have a similarly primitive group with an almost square cross-section. From this type we can easily derive the later two main forms. One becomes flatter and may even be very thin with straight lateral faces, while in the earlier versions of the other the upper surface is rounded off a little; later an intermediate form arises, bounded by two sharp lateral edges which give this type of axe or pick an almost triangular cross-section. We may well say "later" here, for these axes are sometimes of such fine material as petrified wood, chalcedony and agate and are so beautifully polished and finished that it is obvious that they are connected with the final phase of the Javanese Neolithic period.

Many of these exquisitely beautiful axes have never been used: we can only surmise the purpose for which they were made. Nowadays we can still see on some of the Polynesian islands ceremonial axes which are not utensils but symbols of dignity, while in New Guinea large and exceedingly beautifully finished axes are used as a medium of barter, playing a particularly important part in the buying of a bride. Professor Bos suspected that our Javanese axes were also perhaps intended as a medium of barter, i.e. a kind of money. Perhaps they were also used to conjure up rain, for in Javanese eyes the clouds in the stones symbolize clouds in the sky. That we are indeed justified in suspecting the existence of rain-making rituals is shown by the large kettledrums of the Indonesian Bronze Age, which are embellished with fish and water-birds and generally have large bronze frogs sitting on the top, as symbols of water.

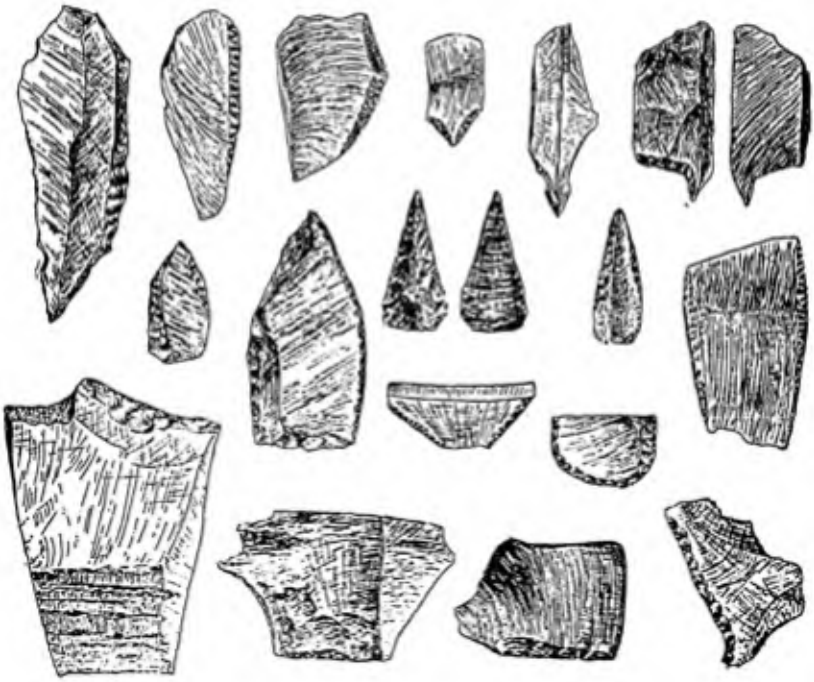
As to its form, the Javanese stone "axe" is seldom an axe in the literal sense. The upper and lower surfaces are slightly divergent, so that the blade is perpendicular to the handle. In form, therefore, it corresponds to the *patjol* of the Indonesians, which is used in tilling the soil. Perhaps, then, our axes

were partly agricultural implements and partly woodworking tools: small stone chisels were particularly suited to these purposes. The type with a cutting edge parallel to the handle is rare and therefore clearly a copy in stone of a bronze axe.

In the Southern Range near Punung, Stein also found large workshops where stone axes were made. Here, where raw material was immediately available, we find thousands of axes, whole or broken, in all stages of manufacture. First a lump of stone was shaped roughly into a square with the aid of another stone and then, probably with pieces of bone or hard wood, painstakingly retouched. These as yet unground axes, called "blanks", were then traded and only ground and polished by the user himself. In Java, polishing was probably done with young bamboo leaves, which contain microscopic quartz crystals and therefore make excellent polishers.

Other characteristic objects of the Javanese Neolithic period are stone bracelets made of chalcedony. A workshop for these is known in the region of Karang Nungal, south of Tasikmalaja, on the south coast of Java. Here not square but round "blanks" were made, these being then ground and carefully polished. There is a second type of bracelet, but this is always made of green jasper, perhaps in imitation of jade. A hollow bamboo cane is used to bore out the centre on both sides, so that a narrow ridge remains on the inner edge. A third form of bracelet has been found only on one occasion, but there were so many specimens that this may be considered a special type. In the course of the geological survey in the Ardjawinangun region near Gundi in Central Java, we found rings made of thick *Tridacna* clam shells, which are still used nowadays in the Pacific as material for bracelets and axes. Our Javanese bracelets of this material were shaped somewhat like a short cylinder, bored out on the inside and outside.

Among the more important sites of the Neolithic period is the Bandung district. At the present day the lowest part of the plateau is still very swampy, and in prehistoric times there must



32 *Microlithic obsidian implements from Bandung, Western Java.* Scrapers, blades, borers and points

have been a lake here. The plain was cut off and the lake dammed by a stream of lava from the Burangrang volcano. Later a cleft was torn in this natural embankment by the Tjitaroem River, so that the lake ran dry. In Sundanese tales, the lake of Bandung still plays a role and probably, amongst other things, the name of Udjungbrung, a place east of Bandung, is also a reminder of it, for "Udjung" means "Cape". Round this prehistoric lake we now find numerous prehistoric sites. The material used for making smaller implements is

chiefly obsidian, black volcanic glass, which is found in large quantities farther east in the neighbourhood of Nagreg. It occurs, however, mainly in the form of small volcanic bombs, which is probably why the implements remained so small, so that we may speak in this connexion of a "microlith" culture. At the sites we find thousands of obsidian splinters, while small knives, scrapers, borers and arrow-heads are easily recognizable. We regularly come across small arrow-heads with a diameter of only 3–5 mm., probably kept so small because blowpipes were used to dispatch the arrows. We still find blowpipes—and, as far as I know, this is unique in Java—being used in districts quite close to Bandung; these are shorter than the Borneo ones, being usually no more than a yard long; furthermore, we find the remains of rough earthenware and the characteristic, sometimes beautifully finished axes. Some Swiss colleagues also discovered moulds for metal objects on the sites near Dago, north of Bandung, during the war; so that here, too, we must be in the final phase of the Neolithic period.

This brings us to the point at which the Stone Age runs into the Bronze Age, and the latter lies outside our present discussion.

But there still remains one last population group which we must consider here—the friendly Polynesians, who are probably related to the Proto-Malays. Nowadays the Polynesians inhabit the islands in the Pacific situated within the huge triangle formed by Hawaii in the north, New Zealand in the south and the small, difficult-to-locate Easter Island in the east, not far from the coast of South America. With their primitive ships the Polynesians succeeded in reaching both these and the intermediate groups of small islands long before these were "discovered" by the Europeans: Easter Island (called "Rapanui" by the Polynesians), by the Dutchman Roggeveen on Easter Day in the year 1722; Hawaii, by the English explorer Captain Cook in 1778. To their amazement, the Europeans found all these far-flung islands already inhabited by a relatively

homogeneous population. Where had it originally come from? The problem of the provenance of the Polynesians has recently become acute again. The Norwegian Thor Heyerdahl attempted to show by his Kon-Tiki Expedition that America must have been their place of origin, and he published his scientific findings under the title of *American Indians in the Pacific.*

We have no wish to disparage the sporting achievements of Mr Heyerdahl, but his scientific findings have not been received with enthusiasm either by ethnologists or archaeologists. It has long been known that the Polynesians must have been in contact with South America. The *mere*, a short, flat stone club, so characteristic of New Zealand, has more than once been encountered in prehistoric graves in America; but such contact can never have been close. The Polynesian languages are directly related to Malay languages (formerly they were referred to as "Malayo-Polynesian", nowadays this term has been replaced by "Austronesian"), and East Asian prehistory, especially that of Formosa, the Philippines and Indonesia, still provides the key to the Polynesian culture.

As has been clearly demonstrated by Otley Beyer, it is particularly the stone axes from the northern Philippines that enable us to recognize a distinct connexion with Polynesia (chiefly Hawaii) which, until the advent of the Europeans, was still in the Neolithic stage. The shape of certain weapons and implements, moreover, leads one to suspect that the Polynesians must originally have known metal objects, but that such knowledge was lost through migration and isolation, so that they subsequently fell back on the use of stone implements.

At least one of the Polynesian migrations eastward must have started from the Philippines. What part the southerly Indonesia played in this migration still remains to be solved. There is a striking similarity between the decorative art of Borneo—spiral motifs and masks with long, lolling tongues—and that of New Zealand. The inhabitants of the Mentawai Islands which lie off the west coast of Sumatra are, according

to Keane, the closest to the Polynesians. It has even been suggested that, on linguistic grounds, there is a link between the names of "Java" and "Hawaii".

During the last war the Geological Museum of Bandung received two stone axes of the Polynesian type said to have come from Serang, situated at the western end of Java, opposite Sumatra. Circumstances at the time prevented further investigation into the origin of these interesting finds.

In the southern part of Sumatra, never reached by Hinduism and only later by Mohammedanism, old motifs have survived on fabrics and cloths. Some of these motifs must assuredly go back to the Indonesian Bronze Age, as we are familiar with similar representations and ornamentation from bronze objects. On these cloths representations of figures have been found, very probably idols or images of deities, with gaping mouth and wearing curious helmets, which are practically identical with the Aumakua images of Hawaii. Another remarkable textile motif consists of bird-men that vary as to the position of the hands.

This last motif brings us back again to Easter Island, whose huge stone statues are considered to render it so mysterious. These are perhaps rather less remarkable than most people imagine, for it is obvious that the soft volcanic tufa to be found on the island made carving easy and inspired the making of these colossi. Much more noteworthy are the small wooden boards covered with hieroglyphics which were only very recently deciphered. These hieroglyphics consist of simplified representations of plants, birds, human beings and bird-men, like those of Sumatra, with various attributes expressed through their hands. The origin of this script is one of the greatest problems of ethnology, for we have no grounds for supposing that the people of this little island discovered the script by themselves. It was De Hevesy who compared these hieroglyphics with similar signs found in the prehistoric settlements at Harappa and Mohenjo-Daro in the Indus valley in Pakistan.

33 Hieroglyphs: from the Indus Valley (*left*) and from Easter Island (after De Hevesy)

34 Characters representing man, bird-man, birds, snakes, etc., from Sumatra (*left*) and Easter Island. Note the astonishing similarity in spite of the great distance

There is a certain resemblance between these two groups of signs, though there is also one very important difference: the hieroglyphics of Easter Island are always in silhouette, whereas those of the Indus valley consist only of strokes. It is the bird-men of Sumatra who are represented in silhouette and thus correspond much more closely to those of Easter Island. Apart from this, Sumatra might be considered as the starting-point

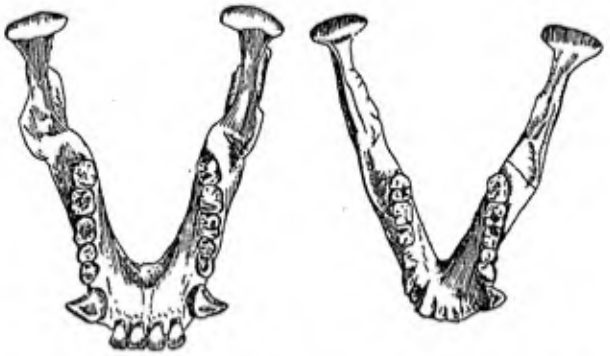
of one of the Polynesian migrations, so that the Polynesians perhaps already brought a knowledge of the signs with them from Asia, even though this was very largely, but not completely, lost again later on account of their isolation. It may not be out of place to mention here that the strong influence of the so-called "Megalith culture" is to be traced throughout the whole of Polynesian culture. Large stone terraces, stone structures and especially the erection of oblong stones called "menhirs", singly or arranged in series, are aspects of this Megalith culture. On Easter Island, stone terraces as well as the huge statues point to the influence of this culture, of which there is an old centre in southern Sumatra. Recently an expedition under the leadership of Dr Funk of the University of Cologne discovered numerous menhirs in this district, one of which, on the slopes of Gunung Tanggamus, is 60 feet long.

We may seriously ask ourselves, therefore, whether perhaps one of the Polynesian migrations set out from the southern Sumatra–Java area. We are justified in raising the question, although it cannot as yet be answered.

AFRICA

The Island of Apes

REMAINS OF FOSSIL APES are extremely rare in all parts of the world—except East Africa. As early as 1933 some fossil apes' teeth, strongly reminiscent of chimpanzee teeth, were recorded from this region. Since the London Zoo at that time housed a particularly popular chimpanzee called Consul,



35 Lower jaws: *left*, of a modern chimpanzee; *right*, of a *Proconsul* from Rusinga. The latter is devoid of the "simian shelf" in the chin region possessed by all living anthropoid apes (after Le Gros Clark and Leakey)

the new ape was dubbed *Proconsul*. After the appearance of the first publication, Dr L. S. B. Leakey, Director of the Nairobi Natural History Museum, went ape hunting, ably supported by his wife, Mrs Mary Leakey, and his assistant, McInnes. The most productive hunting-ground proved to be

a group of islands in the Kavirondo Gulf of Lake Victoria Nyanza, and particularly Rusinga Island.

The story of the anthropoid apes is at least as exciting as that of man and even more obscure. We do not know the immediate ancestor of either the chimpanzee or the gorilla. And of the fossil orang-utan we possess only a few isolated teeth that may date from around the beginning of the Ice Age. These remains come from South China, the neighbouring territory of Indonesia, and Java—all regions in which the orang-utan no longer occurs. The extinct orang-utan of the Asian mainland must have been appreciably larger than the living species, being at least as big as a well-developed gorilla. Of all anthropoid apes the orang-utan seems the farthest removed from man; whether we can say the same of the fossil appears to me doubtful. The extant form has probably undergone great modification as the result of its isolation in the confined habitat of Borneo and Sumatra, and no doubt differs considerably from the original form.

The oldest recorded ape remains come from North Africa—from the Fayum, south of Cairo. They were found in 1910 by Herr Markgraf, an unsuccessful German musician who collected for various museums, and are today in the Württemberg Natural History Museum, Stuttgart. They consist of three fragments of mandible, which originate from small forms belonging to three different species and recovered from the same levels as yielded the oldest remains of elephant. These finds must be approximately 30 to 40 million years old, those made in East Africa about 20 to 25 million years.

But Europe and Asia also had their anthropoid apes. A lower jaw with gorilla-like dentition was found in France as long ago as 1856 and christened *Dryopithecus*. The "manlike teeth from the granular limonite of the Swabian Alps", described by Branco in 1898, belong to another species of *Dryopithecus*. It requires no great stretch of the imagination to take some of these teeth for human.

Rusinga, where the *Proconsul* skull was found (below the tree, where our collector is standing)

The *Proconsul* skull from Rusinga, the only fossil anthropoid's skull yet found. *Right*: a further cranial fragment

Rusinga: typical geological exposure in a dry water-course

East Africa: landscape on Rusinga Island in Lake Victoria Nyanza

It soon became evident that *Dryopithecus* must have been very widely distributed, for its remains are known from Spain, Egypt and India. To talk of "remains" is perhaps an exaggeration, for they are practically all merely scraps of jaw-bone or isolated teeth. A further anthropoid ape was described as *Sivapithecus*, because it came from the Siwalik levels at the foot of the Himalayas. Later, we found analogous forms in Spain and East Africa. The dissemination of the various genera seems, therefore, to have been strikingly widespread.

Anthropologists, in their search for a possible ancestor of man, have always looked amongst the twenty or so varieties of anthropoid apes so far known. Although the recorded forms appear over-specialized, it is generally assumed that a fairly close affinity exists between man and the *Dryopithecus* or *Sivapithecus* groups. Indeed Pilgrim, who instituted the genus *Sivapithecus*, originally assigned it to the Hominids. A slightly smaller genus, *Ramapithecus*, was described by Lewis as the progenitor of man, but neither of these views has stood up to criticism. Nevertheless, the large number of genera of the higher Primates in India lends support to the belief that Asia was the cradle of the human race.

Another continent that has also established a claim to this title recently is Africa. It is a fact that the oldest simian remains are African, and that the singular half-men from the beginning of the Ice Age were found in South Africa. The role played by Africa in the evolution of man is not yet clear. The oldest elephants are also African, and yet the transition from the primitive forerunner to the type of elephant still extant took place in Asia.

At all events, the earlier phase in the prehistory of the anthropoid apes takes place in Africa, and within this prehistory the finds in East Africa occupy a very special position. Everyone who wishes to go deeply into the history of man must come to terms with them. For me it was a great experience to become personally acquainted with these finds and sites.

We left Nairobi in the morning of March 7, 1951. McInnes had offered to accompany me to Rusinga. Nairobi—which is inhabited by more Indians than Europeans and whose most imposing building is not a church but the Aga Khan Mosque —stands on a plateau. The road led us first between plantations and past the little Kikuyu villages with their round huts; the land is flat, with few hills. Suddenly the traveller finds himself on the edge of a steep drop, looking down into a depression more than 3,000 feet deep—the Rift Valley. The earth here is fissured by great rifts running from north to south. This system of fissures extends northwards from East Africa to the extremity of the continent, crosses the Red Sea, and ends in Palestine's Jordan Valley, and must be the most extensive area of its kind in the world. From these rifts the molten magma rose to the surface, and so we find here various volcanoes, such as Kilimanjaro, somewhat farther south, the highest mountain in Africa.

The road plunges downwards in vast hairpin bends. In the valley itself are a number of smaller mountains, such as Suswa and Longonot, whose conical shape betrays their volcanic origin. At this point the valley is about 45 miles wide. To begin with, the road runs along the floor of the valley past various small lakes. First comes Naiwasha, an old crater lake that can be admired on Kenya's stamps; farther north lie a few other small lakes, on the edge of which a crust of salt is deposited during the dry season. These lakes contain a multitude of little water-fleas and similar creatures that provide food for thousands of long-legged flamingoes, which we saw standing in the water fishing. There was little game—a few zebras, that was all. The Italian prisoners-of-war who built a network of modern roads here during the war wrought fearful havoc among the wild life. Beyond Nakura the road rises again. On the plateau we found large plantations, and it was astonishing to see what a European look the British had given to the countryside by the style of their settlements. Then we descended again through

great sisal plantations, and at Kisumu, some 300 miles from Nairobi, we at last reached the shores of Lake Victoria Nyanza. Kisumu is a sleepy little settlement with a luxury hotel much too large for it, a melancholy reminder of its past glories. A few years ago it possessed busy airfields: people flying from Cairo to the Cape used to spend the night here. Then aeroplanes were so much improved that it became unnecessary to break the journey, and Kisumu's fate was sealed.

Our boat was already waiting for us. It belonged to the Nairobi Museum and bore the name *Miocene Lady*, possibly a discreet allusion to the fact that in a lady age is of no importance. We sailed cautiously out of the harbour and into the Kavirondo Gulf which, although it looks insignificant on the map, is nevertheless over 30 miles long.

Our first goal was the little island of Kiboko, on which digging had been carried out only a short while before. These excavations had produced, in particular, remains of the pig-toothed elephant, the mastodon, and bones of primitive rhinoceros, but few simian remains. We spent only half an hour or so on the island, since we were in the zone of the dreaded tsetse-fly. Fortunately none of us was stung (the sting is so painful that at least the victim knows when he has been stung) and as soon as we were back on board our clothes and the whole boat were thoroughly sprayed with insecticide. Then we sailed on to Rusinga Island, which is about 6 hours' voyage from Kisumu.

Rusinga is an idyllic island with a few small fishing villages. The boats interested me greatly, as they are—strangely—constructed after a Malayan model, while their painted decorations definitely recall those on Balinese *prahus*. Malayan influences must have been at work here, and it is to be assumed that they reached this part of Africa from Madagascar. The interior of Madagascar is inhabited by Hovas, who immigrated in prehistoric times from Indonesia, but have been pushed back from the coastal strips by the more malaria-resistant Negroes.

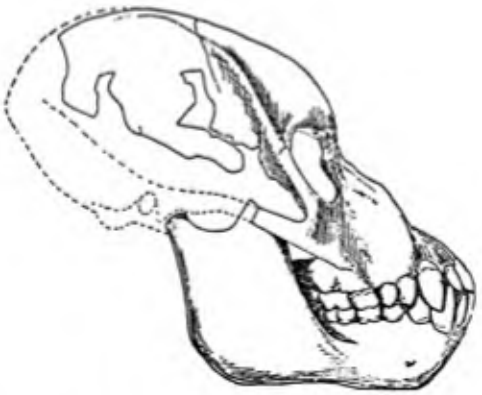
The stratification on Rusinga consists of sandstone, tufa and deposits from earlier freshwater lakes. Above all, the volcanic element must not be overlooked, for just as volcanic activity is probably the prime reason for the occurrence of human remains on Java, so here in East Africa it is the factor to which we owe the abundance of simian remains. In other respects, too, volcanic deposits create conditions under which the more perishable forms of organic life may be preserved. Thus on Rusinga not only have perfectly fossilized fruits and seeds of Miocene plants been found, but also—and this, as far as I know, is unique—whole insects have been preserved intact. Among the latter are numerous locusts (pointing to open grassland), ticks, the egg-cluster of a large praying mantis, and even caterpillars complete with feet.

We carefully examined the slope that had already attracted attention by its fossils, and we actually had the luck to discover first a few small rodents' jaws and then a fragment of a *Proconsul's* mandible with a canine tooth. We spent the night on our boat, and the following day visited the classical fossil bed in which Mary Leakey had found her *Proconsul* skull. There is nothing remarkable about the little hillock. But Mrs Leakey, who had had the firm conviction that something special would emerge at just this spot, did not give up till she had turned every stone and actually found a skull—the first complete cranium of a fossil anthropoid. The discovery caused such a sensation that she flew at once to England, where her find was prepared and examined in the British Museum.

Today we know three different species of *Proconsul*: one of them is rather smaller than a chimpanzee, the second about the same size as a chimpanzee, while the third is as big as a gorilla.

The lower jaws do not extend as far back behind the chin as in modern anthropoids—they lack the specialized feature known as the simian shelf—but exhibit in this region the abrupt drop characteristic of the human jaw. For this reason some anthropologists have assumed an affinity between *Proconsul* and man,

and claimed Kenya as the cradle of mankind (with a question mark). Such a claim is certainly unfounded. It may, however, be assumed that the human jaw displays more original features than that of the anthropoids, and therefore differs less from the primordial type.



36 The *Proconsul* skull from the Rusinga Miocene. It lacks the massive eyebrow ridge of the modern anthropoids (after Le Gros Clark and Leakey)

The cranium found by Mary Leakey differs from all modern anthropoid skulls. It has no eyebrow ridge, as might have been expected, and the angle of the orbital plane is less frontal and more lateral. The shape of the nasal aperture is also different, more closely resembling that of the lower apes, as is also true of the cerebral relief, which at one point, where the brain-pan is missing, may still be clearly seen imprinted in the rock.

It therefore seems that *Proconsul* represents primarily an intermediate stage between the lower and the anthropoid apes, rather than between the latter and man. From foot-bones that

have been recovered we can deduce that it did not live exclusively in trees, but also moved about on the ground a great deal. Unfortunately the cranium is crushed and the back of the skull incomplete, so that the cranial capacity cannot be determined.

In any case, we have in *Proconsul* a primitive representative of the anthropoid apes, probably dating from a period when the group had not become differentiated in a simian direction (i.e. in the direction of the modern anthropoids) on the one hand, and in a human direction on the other. In judging the human dentition we are unfortunately confronted by so many prejudices, and the criteria we apply are so beset with theories that we cannot say for certain how far the human type of dentition might be derived from that of the *Proconsul*. Indeed, it is even difficult to classify *Proconsul* as an anthropoid. The dentition alone is enough to prove that the ordinary apes belong to a collateral line and by no means represent a preliminary phase of the anthropoids or even of man. On the other hand, there must have been a more primitive stage below that of the anthropoids, corresponding in its general organization more to that of the ordinary apes. *Proconsul* may be one such form.

Other remains from East Africa prove the presence of gibbon-like apes, which, however, have little in common with the gibbons now confined to Eastern Asia. These apes are one-sidedly specialized anthropoids of small stature.

The remains of ordinary apes are interesting. Our knowledge of the prehistory of this group was previously very scanty. The oldest known specimens in Europe came from the Lower Pliocene of Greece; this group seems to have reached first India and then China only in the Middle Pliocene. Now that the oldest primitive apes have been found in Kenya we may assume that their evolutionary centre lay in Africa.

Incidentally, apes are not yet entirely extinct in Europe: the tailless Gibraltar ape still lives on the Rock of Gibraltar. During

the great warm interglacial period the same species occurred in Württemberg. Other Pleistocene macacos existed in Italy, France, Holland and even Britain.

Miocene strata containing mammals are widespread in East Africa, but largely covered by later strata and therefore inaccessible. The most north-easterly point at which they have been found is on the banks of Lake Rudolf, close to the Ethiopian frontier. The fauna is the same everywhere, with mastodons, a small dinotherium (a ridge-toothed elephant with downward-curved tusks in its lower jaw), proto-pigs and very primitive beasts of prey. Many of these are the last descendants of groups that strictly belong to the Early Tertiary, which gives the whole fauna a very archaic aspect.

During our visit to Rusinga we did not find quite as much as I had hoped, for a British Museum expedition had been there just before and had done a very thorough job of collecting. Nevertheless, we could be content with our haul. No one can leave this lonely, inaccessible spot without the feeling that the most important thing has not yet been discovered and that this is all that matters. After all, fossils are like truth: they are not where you look for them, but where you find them.

The South African Half-men

IN SOUTH AFRICA limestone is needed not only in the construction of lofty skyscrapers and other stately buildings, but also for her industry. And limestone—in this land full of sandstone, granite and gneiss—is a rarity. Hence limestone tufa deposited by springs and calcined cleft-fillings, that would have been ignored in Europe, have been quarried and worked.

We went to see one such calcined fissure in the Transvaal on January 11, 1951. We had come over by car from Pretoria, Dr Robinson and I, and now, after scarcely an hour's journey across the hilly green plateau, we were in Swartkrans. In front of us was a small rift in the grey dolomite rock, about 30 feet

high, in which lay the limestone beds we had come to see, some of them snow-white and glistening, others coloured red by the sand that had been blown into them.

It was only the hard red and yellow limestones that interested us. They were the filling of an old cave or cleft and contained a quantity of bones and teeth. This fissure must have had an entrance on the surface. Whether it was inhabited cannot be said for certain; probably the rains swept in the bones and the wind blew in the red desert sand, until the crevice was full. Much later, denudation reduced the surface-level and brought these clefts into view, when they were discovered and utilized by men.

If Swartkrans had yielded only the bones of baboons, beasts of prey and antelopes, there would have been no need to visit the spot. But Swartkrans has a speciality that has made this little pit world-famous—*Paranthropus crassidens*. The name *anthropus*, "man", speaks for itself; the grandiose title "Large-Toothed Near-Man" conceals one more problem of our enigmatic prehistory of which we had no inkling prior to 1924.

In that year genial, broad-shouldered Dr Raymond A. Dart, professor of anatomy at Witwatersrand University, Johannesburg, received a singular little cranium that had been found during quarrying at Taungs in Bechuanaland. This cranium recalled a young chimpanzee's, but it had a higher cranial capacity and a very human dentition, so that it was hard to decide whether this was a human or a simian skull. Dart named the find *Australopithecus africanus*, the "African Southern Ape".

This find introduced a totally unsuspected epoch of discoveries in South Africa. The question whether this *Australopithecus* was a man or an ape led to all manner of controversies, which also involved its nomenclature. Dr Broom, who had the good fortune to find more of these remarkable transitional forms, ostentatiously dubbed them *Paranthropus* and *Pleianthropus*. Today we know that the human features preponderate

and that we have here a group of creatures that are closer to man than to the anthropoid apes. According to the international rules of nomenclature, however, they must continue to bear the family name Australopithecinae after that of the first find, although many anthropologists would like to change the name of the genus from *Australopithecus* to *Australanthropus*; such a change is not permitted under the rules, however. The fact that some of the names end in *anthropus*, "man", while others end in *pithecus*, "ape"—although all the creatures belong to the same group—is certainly most confusing for the layman.

In all we know five, and perhaps even six, different species of these australopithecines. The curious thing is that up to the present each form has been encountered in one locality only, so that we must ask ourselves whether each of them really does represent a species, properly speaking. Moreover, it is by no means certain that this group is confined to South Africa. Dr Kohl-Larssen found a small fragment of upper jaw with two large premolars in southern East Africa, and this fragment was later described as *Meganthropus africanus*. There is no certainty that this form has anything to do with our Javan *Meganthropus* (of which we have, as yet, no fragment of the upper jaw)—it is much more likely to be another *Australopithecus*.

All the South African finds have been recovered from cleft-fillings. Almost nothing is known of the stratification of this region; hence it is not easy to determine the age of the sites, although they also contain relics of other mammals. Amongst the latter, baboons, which still occur in South Africa, are particularly numerous. Certain species of beasts of prey create a thoroughly archaic impression, but in Africa this does not necessarily indicate great geological age. We shall meet the chalicotherium and the dinotherium—two beasts that were extinct in Europe more than 10 million years ago—in the Middle Pleistocene of the Serengeti Veldt. A few of the cleft-fillings may confidently be assigned to the Pleistocene, because

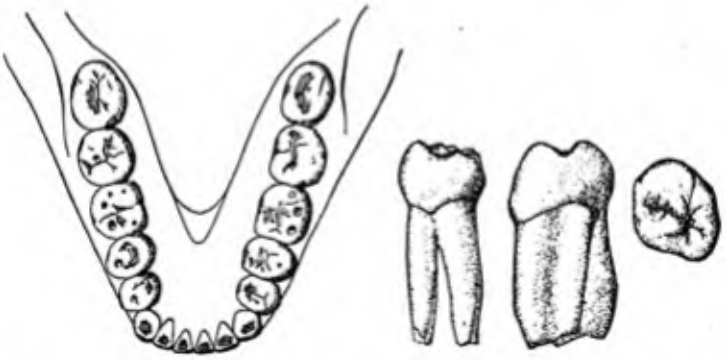
they contain relics of horses, and the horse is the key fossil for this formation. Even assuming a slight difference in age between the various sites, there is no proof that any of the cleft-fillings are of Tertiary age, although our South African friends like to attribute their finds to this epoch. This seems to me a psychological, rather than a palaeontological, problem: everyone would like to possess the oldest finds. In its day *Pithecanthropus*, too, was assigned to the Tertiary by Dubois, and it was not until forty years later that its Middle Pleistocene date could be proved.

Our knowledge of the australopithecines is considerable and at the same time very limited. We possess numerous single teeth, mandibles and skulls of which, however, only a few are preserved in their entirety; of the rest of the skeleton we have little or nothing. The few fragments of arm- and foot-bones do not permit any inferences to be drawn as to the original stature.

The almost human character of *Australopithecus* led Dart to credit him with certain typically human capabilities, namely the use of fire and tools. Dart went so far as to christen his new find at Makapansgat *Australopithecus prometheus* (after Prometheus, who brought fire to earth from heaven), though there was no proof of either hearths or burnt bones at this site. Indeed, Broom—who knows more about the situation in South Africa than anyone else—contested Dart's claim, pointing out that ashes may be derived from veldt fires. The alleged implements consist of short bone clubs displaying clear marks of splitting. Dart depicted a whole series of baboon skulls exhibiting curious round holes attributed to blows with these instruments. Whatever was used to batter in the baboon skulls, it was certainly not these bones. The Makapansgat bones so exactly resemble those that have been gnawed by hyaenas that there can be no doubt that they, too, were broken by these creatures. To cap this evidence, the presence of hyaenas in the locality has been established.

The australopithecine dentition looks very human. The

notorious simian diastema is absent, the canine is small, and the teeth have been worn flat as is typical of man. But more detailed analysis discloses important differences. The incisors are strikingly small, in spite of the large grinders—often smaller than in modern man; the canine is in most cases about the same



37 Lower jaw of the Swartkrans *Paranthropus*. The molars are too large and the incisors too small (after Broom and Robinson)

38 A back lower molar of *Paranthropus* has two strong roots. In man this tooth has only one root (after Robinson)

size as ours, and the first premolar immediately next to the canine is already reduced. By contrast, the molars are very large and show the original ratio to be seen in apes (and, among early men, in our Javanese *Pithecanthropus modjokertensis*).

Looked at from in front the skull possesses an only slightly projecting snout. The face is very much shortened, which is probably genetically determined. The same thing is met with in other groups of animals. It is easy to imagine that this process caused the reduction of the originally larger canines, for which there simply wasn't room any more. This has nothing to do with the use or non-use of these teeth, as was

once so readily assumed. In our Early Pleistocene *Pithecanthropus*, who was certainly human, it is precisely the anterior teeth that still show the original ratio—accompanied by a nasal aperture like that of modern man—whereas the australopithecines have a more human anterior dentition, but a completely simian nasal aperture very reminiscent of the chimpanzee's.

Of particular importance in judging such finds are the milk teeth, which are formed before birth and tend to exhibit original features. In australopithecines these are not merely human, but superhuman. In man the anterior deciduous molar always has a more simple pattern than the posterior one; in the australopithecines we find occasionally that the anterior molar does not differ from the posterior one, except by its inferior size. This phenomenon is familiar from various groups of mammals: it is always a sign of very high specialization. In their deciduous molar dentition, as in their permanent anterior dentition, the australopithecines are more highly specialized than modern man and hence already very strongly divergent from *Pithecanthropus* and *Sinanthropus*.

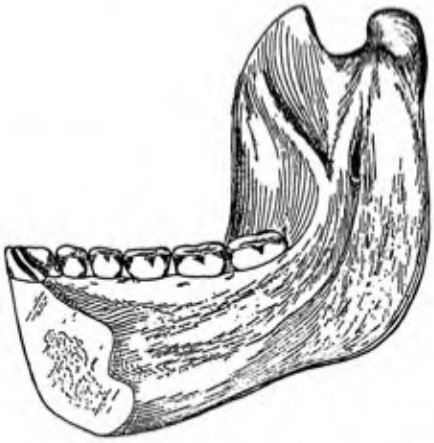
The mandibles, especially of the so-called *Paranthropus*, are extremely thick and massive, recalling the jaws of the Javan *Meganthropus*. Robinson wished to assign our *Meganthropus* to the australopithecines, but that is impossible. Not only is the relief of the crowns of the teeth different, but the last premolar of our Javan form has, as with modern man, only one root, in contrast to *Paranthropus*, in which the corresponding tooth shows two roots, as with anthropoid apes. All the same, the differences are not capital, and we may assume that *Meganthropus* and the australopithecines are derived from the same ancestral form. Except that *Meganthropus* was clearly on the way to man, while the same cannot be said of the australopithecines. Nevertheless, as a few fragments of pelvis show, the latter already walked upright; and the skull, too, was adapted to this position. Apes generally move on all fours, and

if they do walk a short distance on their hind legs they have to wave their arms about to maintain their balance. In an ape's skull the foramen magnum is situated towards the rear edge of the cranium, and the head is supported by powerful neck muscles. In man the head is poised on top of the spinal column, and the foramen magnum occupies a more central position under the cranium. The neck muscles are generally weak. Due to the position of the skull, on the one hand, and the slighter mandible on the other, man's head is no longer compressed by bunches of muscle and therefore retains its childish roundness into maturity. The skull of the young anthropoid is rounder than that of the adult, because of the relatively undeveloped system of muscles, and even displays a rudimentary forehead: this is what gives young apes such a touchingly human look. As they grow older the lower jaw is rendered heavy and massive by the development of the powerful canines, and the attached system of muscles is correspondingly increased. A superciliary ridge develops and in extreme cases, when the masses of muscle meet on the vertex of the head and a bony attachment-surface forms between them, they even acquire a parietal crest, known to anatomists as the *crista sagittalis*.

All anthropoid apes have large canines. These serve not only for self-defence, but equally for opening tropical fruits. One may even imagine that it was the reduction of man's canines which first made him omnivorous or carnivorous, so that in this respect he was compelled to follow a predestined line of evolution.

We have already seen that, working from the skeleton alone, it is not so easy to define man in comparison with the anthropoid ape. Actually, the anthropoid's skeleton differs only quantitatively from our own. The number of cranial bones and teeth is the same; the difference in the structure of hands and feet is also one of degree only—it is worth noting that the mountain gorilla's foot has proved to be remarkably similar

to man's. At one time a difference between man and apes was seen in the absence of the intermaxillary suture in the upper jaw, but in fact there is no difference here. The continuous row of teeth has also proved untenable as a distinguishing feature, now that we have observed a simian diastema in *Pithecanthropus modjokertensis* (which will doubtless also appear in the still older forms we have yet to find). The only distin-



39 Reconstruction of a *Paranthropus* mandible. The jawbone is exceptionally massive (after Robinson)

guishing characteristic left, therefore, is the size of the brain.

The modern anthropoids and man differ considerably as to brain size. This gap has, however, already been largely bridged by the discoveries of fossil hominids. In so far as the gorilla has a maximum cranial capacity of 600 c.cm. and modern man one between 1,350 and 1,500 c.cm., we are able to point to a fundamental difference. But we have seen that Peking man's brain capacity is less than 1,000 c.cm. and that of the *Pithecanthropus erectus* skull from Sangiran only 775 c.cm. It is only too

evident, therefore, that to rely on divergency of cranial capacity as a means of distinguishing between man and the apes will also get us into difficulties. The celebrated British anthropologist Sir Arthur Keith once expressed the opinion that forms with a capacity of more than 750 c.cm. must be regarded as human, and those with less as simian; but we shall see in a moment that here, too, we meet insurmountable difficulties.

40 Reconstruction of the skull of a *Paranthropus crassidens* from Swartkrans, South Africa, usual type (re-drawn after Robinson)

The first *Australopithecus* skull—that of a juvenile—although it was relatively complete, put anatomists in a quandary when they came to calculate the capacity of the cranium. It was given variously—perhaps influenced by the personal outlook of the anatomist—as anything from 450 to 510 c.cm. When it came to deducing the brain weight of an adult specimen, the estimates varied from 550 to 750 c.cm. Since these figures lie on the borderline, on Keith's "Rubicon", they must be treated with extreme caution. There are numerous crania from other

Australopithecus forms, but only one of these is sufficiently well preserved to enable us to measure its brain volume. This is the skull of *Plesianthropus V*, which belongs to a female specimen and is popularly known in South Africa as 'Mrs Ples'. This cranium—that of a fully grown individual—has a capacity of

41 Reconstruction of the skull of a *Paranthropus crassidens* from Swartkrans, South Africa, with parietal crest (re-drawn after Robinson)

only 482 c.cm. in other words, it is no larger than a chimpanzee skull!

The largest crania are those of *Paranthropus crassidens*, which, as its name implies, is distinguished by exceptionally big teeth. According to Broom, some of these skulls have a cranial capacity of more than 1,000 c.cm., which would bring them well inside the *Pithecanthropus-Sinanthropus* stage. Once more, this is only an estimate and one which, for reasons I shall explain, seems to me very improbable.

Excavated fissure at Makapansgat, South Africa

The skull of a young *Australopithecus africanus*

Parietal crests: gorilla (*left*) and *Paranthropus*

At Swartkrans two skulls were found possessing a well-marked parietal crest (Fig. 41). This crest can only be regarded as the sign of a limited cranial capacity. Its appearance in anthropoid apes follows a law that can also be observed outside the australopithecine group.

The distribution of this structure among the anthropoids is very significant, since it is clearly dependent upon the absolute size of the skull. A crest of this kind is never found among the small gibbons and only rarely among old male chimpanzees. Among the larger orang-utans it regularly occurs in the male, and among the still larger gorillas not only in the males but very often in the females as well. This seems to be connected with the fact that the attachment-surface for the jaw muscles does not increase in size in the same ratio as the cranial capacity. Now, the absence of a parietal crest in all the smaller forms of the australopithecines and its occurrence in *Paranthropus crassidens*—the largest representative of this group—constitutes an astonishing parallel with the conditions which characterize the anthropoids, and a marked divergence from the typically human morphology of the calvarium.

Hence, even if the australopithecines could be shown to fill the gap between the anthropoids and man, where their cranial capacity is concerned, this would not necessarily make them man's ancestors. All anthropoids have a large jaw, whereas the human dentition is both absolutely and relatively small. A glance at the history of man back to *Pithecanthropus* and *Meganthropus* shows that our dentition has grown progressively smaller in the course of evolution and our brain progressively larger: this is one of the most striking features of human evolution. In the australopithecines, on the other hand—as is normal for the anthropoids—the smaller forms have smaller teeth and a smaller brain, and the larger forms larger teeth and a correspondingly larger brain.

This comparison, which may be rather difficult for the reader to follow, has been made in order to demonstrate that the

australopithecines—although they are to be regarded as morphologically human in the widest sense—were stuck fast at the simian level. They do not represent a group at an earlier phase of the same line of development as that on which *Pithecanthropus* and *Meganthropus* lie; and their over-specialization puts them out of court as a primitive stage of ancient man.

Man is a cerebral animal, the brain is his peculiar characteristic. Specifically human evolution—in contradistinction to animal evolution—depends upon the development of this typically human organ. If, then, we compare these South African half-men (this seems to me the best name we can give them—the South Africans like to use the term "ape-men", in contradistinction to the "man-apes") with the anthropoids, it becomes manifest that they do not differ from the latter in relative cranial capacity. In a sense, therefore, they represent the animal equivalent of man. We may assume that, to begin with, the Hominids—i.e. the human group in the widest sense—parted from the anthropoids without, at first, developing into something fundamentally different. Within this group there was a sub-group—our South African half-men—whose evolution ran more or less parallel with that of the anthropoids and was distinguished from the latter firstly by their erect gait and secondly by the reduction of their canine teeth. At a very early stage there branched off from this group the line that led to modern man; whereupon man entered upon a phase of evolution that was specifically human and characterized by a reduction of the dentition and—perhaps linked with this—an extreme growth of the brain.

I am well aware that the measurable cranial capacity is not necessarily decisive. Even today there are people of great brilliance with relatively small heads, and many of the typically human qualities depend physiologically upon a great complexity and differentiation of the outer cerebral cortex. Nevertheless, when we are considering average figures, a general

increase in the cranial capacity is extremely significant. Children whom an unfortunate combination of hereditary factors has given an excessively small brain, a condition known as microcephalism, do not develop into complete human beings. The history of evolution shows again and again the decisive role played by brain size in the struggle for existence. The huge, totally extinct saurians of the Jurassic and Cretaceous periods were so stupid, i.e. they had such small brains, that in many cases the endocranial cast can without difficulty be drawn out through the foramen magnum. The clumsy, hoofed animals of the Early Tertiary and the primitive carnivores, the Creodonts, were ousted by obviously superior forms with bigger brains. But the increase of brain that occurred in man is unique in the whole history of evolution and manifestly the basis for his ultimate supremacy over the rest of nature.

We must now return for a moment to the great Javan *Meganthropus*. As previously remarked, his massiveness renders him in many respects (unfortunately there is as yet little material on which to base a comparison) akin to certain australopithecines, although all his features known to us prove him a true human. From this we may infer that the australopithecines and *Meganthropus* are derived from a common ancestor; indeed, a great deal of evidence indicates (we must recall here the China giant, *Gigantopithecus*) that at the end of the Tertiary the original group of Hominids split into a large number of sub-groups, and one of these that was particularly progressive developed into modern man.

Some jaw fragments were found at Swartkrans that do not look as coarse and simian as the remains of *Paranthropus* recovered from the same site. There is still a good deal of argument about these finds, which have been given the name *Telanthropus*. Some anthropologists believe that this is a genuine transitional form between the australopithecines and man, a view that seems to me, on the basis of what has just been said, extremely unlikely. Others believe that these are

merely some very weakly specimens of *Paranthropus*. Taking into account the geological age, which in my opinion is not as great as is generally assumed in South Africa, this might well be a genuine primitive man who was already a contemporary of the australopithecines.

In any case, the last word has not yet been spoken on this question. The exciting thing about South Africa is that here palaeontological work is proceeding intensively and undisturbed, so that new and spectacular finds may come to light at any moment.

Their association with large numbers of baboons, and the desert sand that has been blown into the deposits in which they lie, suggest that the australopithecines lived in an arid, semi-desert region—a fact which, in conjunction with the geographical situation near the southern tip of Africa, renders it very unlikely that we are dealing here with a centre of human evolution.

The discovery of the australopithecines has given an entirely new slant to the problem of the coming of man. Previously people believed in an antithesis, Man—Ape, and supposed that man must inescapably fulfil his human destiny. Now this has been proved an illusion. Only one branch of the Hominids—perhaps with a few secondary offshoots—bit into the apple of knowledge and reached the summit from which their eyes could gaze not only into their immediate surroundings but into the cosmos. Another, conservative branch was unable to free itself from its attachment to its animal origins. *Australopithecus* is a tragic case: he was left behind in the school of life. It would be a mistake to blame this on his teacher.

It is probable that the australopithecines, like the majority of ancient Primates, were far more widely diffused than existing evidence would lead us to suppose. They are known to have lived in South Africa, and there are indications of their presence in East Africa. A few of the teeth from Chinese chemists' shops strongly suggest that representatives of this interesting group

may also turn up in Asia. Broom has suggested that *Gigantopithecus* might have been an Asian australopithecine. This is not impossible, although his grinders have much higher crowns than those of the South African forms; but there is a good deal of evidence for an Asian origin of the australopithecines. As we know them hitherto from Africa, they were small-brained, big-toothed immigrants—pushed aside into inhospitable regions —to whom *Pithecanthropus* must have seemed a genius and Peking man superhuman. Somehow or other they missed the road to humanity.

Oldoway Gorge and Lake Olorgosailie

THE SERENGETI STEPPE in Tanganyika Colony (formerly German East Africa) is famous for its abundance of game. Antelopes, giraffes, zebras and lions roam about this paradise that contains no human settlements, but only an occasional family of nomad Masai with its herd of cattle.

The Serengeti is as flat as a table. Nevertheless, the Oldoway River has cut a deep gorge for itself. In the southern section, the Balbal, a great mass of rock has caved in and subsided. The difference in level was sufficient to allow the river to hollow out a deep valley with steep sides, in which all the layers of rock are visible that are otherwise hidden beneath the surface of the steppe.

The Oldoway has, in fact, eaten its way into the horizontal sediments of an ancient lake, in which a copious fauna lies buried. Bone splinters and fragments of teeth are to be found all over the sides of the canyon; for the most part they are remains that have lain for a long time in the tropical sun, have completely disintegrated, and are now beyond saving. But new material is for ever being exposed, and so nature sees to it that —even without excavating—we now and again find a fragment of jaw or a complete bone. The Munich zoologist, Professor Kattwinkel, discovered the fossils here and realized

the importance of the site shortly before the First World War. Hans Reck, who was really a volcanologist—I remember him well from my student days in Berlin—and who happened to be in East Africa at the time, started systematic digging soon afterwards and was able to conclude his work before the outbreak of war. The fauna he recovered was remarkable enough, although it undoubtedly dated from the beginning of the Ice Age. It consisted of large elephants, not only of a type allied to the modern Indian elephant but also mastodons and dinotheria, which were not to be expected in these recent levels. Mastodons, primitive pig-toothed elephants, died out in Europe at the beginning, in North America at the end of the Ice Age. The dinotherium is a ridge-toothed elephant with long, downward-curving tusks in the lower jaw that disappeared from Europe during the Pliocene. In addition to single-toed horses of the modern type a few three-toed species were represented. A considerable proportion of the fauna consisted of archaic stocks that had managed to subsist in this "game preserve" until into the Pleistocene. Further abundant relics of rhinoceros, hippopotamus, pig, primitive antelopes and giant primeval giraffes were found. But the most notable discovery was a perfectly preserved human skeleton that did not differ in any respect from modern man. The cranium had a high forehead, the lower incisors were filed to a point, the limbs long. Was it an ancestor of the Masai who still inhabit the region? How did this *Homo sapiens* get into such ancient strata? Had he really been a contemporary of all these extinct animals without himself changing?

Leakey had discovered in the Lake Victoria Nyanza district primitive stone implements from levels whose age must correspond to that of the Oldoway strata. When—shortly after the First World War—he prepared to make an expedition to Oldoway itself, he invited Dr Reck to accompany him. Furthermore, he wagered that he would find the first stone instrument at Oldoway within twenty-four hours. Once at

the gorge, it was only six hours before he appeared triumphantly brandishing a magnificent stone axe he had recovered from the exposed strata.

Nowadays it is not as difficult to visit Oldoway as it was in Reck's time. We had left Arusha, at the foot of a lofty volcano, in the cool of the morning. Oddly enough, the volcano is called Meru, a name that might just as well be Indonesian. Before reaching Serengeti in our car we crossed another mountain range, behind which the great Ngorongoro crater lay concealed. This is the largest crater in the world, more than 13 miles across and several hundred yards deep. In the centre is a small lake, with no outlet, that always contains water—even during the most intense drought. In the dry season practically all the animals from the Serengeti make their way to this lake. They have trodden broad tracks that look from a distance like man-made roads. Very often something like a hundred thousand head of game gather here as though in a paradise. When we arrived, the rainy season had already started and most of the game had left the crater. But numerous zebras and gnus and a few giraffes were still to be seen from the idyllic observation house that offers a comfortable refuge up above on the edge of the crater. Today Serengeti and the Ngorongoro crater are wild-life reserves, and so the animals have become trusting and easy to watch. During our descent to the steppe we met several herds of zebras and antelopes. These creatures apparently took a great delight in racing with our car and then, at the last moment, running across the road just in front of it. The region was almost completely devoid of human beings, apart from occasional small groups of Masai with their cattle. Since the Masai's staple diet is the blood of their cattle, and since each beast has about three pints of blood drawn from it every forty days, a medium-sized family requires a whole herd for its sustenance. The men are very proud and armed with little else than a long spear; the women generally remain shyly in the background. They are festooned with

countless metal rings; in the past these were bronze, but nowadays the Masai women have "gone modern" and wear aluminium.

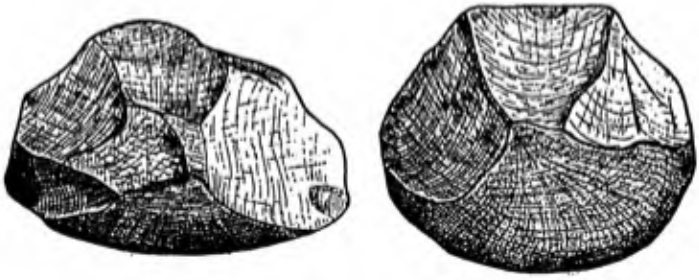
The same afternoon we pitched camp on the rim of Oldoway Gorge. We merely set up our camp-beds beside the car, and our black guides provided us with a tasty supper. Leakey placed his rifle beside his bed. But he assured me that there was really no danger. Lions, he said, are very inquisitive, and if they can't quite make out what is going on they like to hang around the camp. But if everything is open and above board there is nothing to fear from them. In fact, we did not see any lions; only a young bull giraffe that stood for a good half-hour near our camp, continually eyeing us and lashing his tail, until at last he had had enough and vanished into the steppe.

Oldoway Gorge is a magnificent natural open lode, from which the history of the whole district can be read off without much difficulty. The deepest strata consist of a black basalt that obviously flowed here from a neighbouring crater and behind which the dammed-up water formed a lake. The two lowest layers are grey and one of them is more calcareous than the other. Above the basalt lies a 100-foot-thick bed that is bright red and must have been formed during a dry period; it is clearly visible from several miles away. Above this lies another set of grey strata, likewise old lake sediments; and this is blanketed by the recent steppe-limestone of the Serengeti. Even as we clambered down the gorge, which is over 300 feet deep, we found on all sides weathered bones and teeth. Stone implements were rarer and occurred principally at a few circumscribed sites, to which Leakey led us.

There is a magnificent view not only from the upper edge but especially from the depths of the gorge. Stratum lies upon stratum, neatly arranged by nature; and everywhere fossils and stone tools enable us to picture the fauna of bygone ages in our mind's eye. The distinctive feature of the Oldoway profile is that it not only illustrates part of the history of African

animal life in a succession of different faunas, but also presents a more impressive picture of the development of human culture than is to be seen anywhere else in the world. Although no skeletal remains of man have yet been discovered here, such finds may confidently be expected.

In the deepest strata—and these are the ones that contain the most archaic elephants—we find any number of pebbles in



42 Typical implements of the South African Oldowan culture

which a cutting edge has been produced by a few blows. Generally they have been given one blow from the right side, one from the left, and then another from the right, so that the edge acquires a slightly zigzag shape. At first we thought this might be fortuitous, but when some twenty or thirty of these pebbles came to light in an hour we realized that the method of shaping was premeditated. In fact, these are extremely primitive implements, roughly corresponding to the hand-axes found in Europe. British writers describe these instruments as "biface", because they have been worked symmetrically from both sides.

No equally primitive pebble culture is known from Europe. In conformity with the usual practice of naming a primitive stone culture after the first site at which it was discovered, this

culture was christened by Leakey "Oldowan" after the Oldoway Gorge. Apart from these archaic hand-axes, the same levels have yielded numbers of stones that have been chipped until they were roughly spherical. With their multiple facets they look rather like models of crystals that have come to grief. These stones are enormously widespread in Africa, occurring both in the north and south; indeed, at Ain Hanech, east of Algiers, they are the only signs of human culture that have been found there in association with fossil remains of elephant and giraffe. They are believed to be an extremely primitive form of throwing ball.

Stone balls of this type, known to them as *bolas*, are still used by native hunters in South America. They are tied in little leather bags and two or three of them attached to a long cord. Holding one ball in the hand, the hunter whirls the other one or two round his head and then lets fly. One ball strikes its target, whereupon the others wind themselves around the animal's leg, either breaking some bones or hobbling it, so that it falls an easy prey to the hunter.

Above the level containing the Oldowan hand-axes, the geological profile of Oldoway comprises a total of nine further strata that demonstrate in positively classical fashion the development of the hand-axe. At an early stage fairly large, almond-shaped pieces of stone were selected and dressed by means of blows from right and left, producing a cutting edge that often ran round the whole stone. Implements of this kind were first discovered in France and, to begin with, were generally assigned to the Chellean culture-period called after Chelles, near Paris. In recent years, however, this designation has been abandoned in favour of Abbevillian, from the little town of Abbeville, near Amiens. We must suppose that the flakes were generally struck off with other pieces of stone.

While the Abbevillian hand-axes, which have been found in four distinct horizons in the second Oldoway level, are still rather thick and crude, the upper stratum has yielded tools

representing a transitional phase bearing the name Acheulian from St Acheul, also on the Somme near Amiens, where this type of implement was first found. The hand-axes of this stage are much thinner and more regular; the edge is no longer zigzag but straight. For man had meanwhile learned a new technique: the flakes were no longer struck off with another stone, which made them coarse and irregular, but pressed off with a piece of bone or hardwood. This technique is called retouching. In the red stratum at Oldoway we find Horizon VI, representing a transition from Abbevillian to Acheulian; and in the upper grey strata are five further horizons in which the Acheulian hand-axes attain greater and greater perfection. In addition to the hand-axes, which are characterized by a point, there are other instruments—called cleavers—having only a straight cutting edge.

The hand-axes are highly remarkable in a number of respects. In the first place, the hand-axe culture as such is extremely old and endured for a period of some 400,000 years with very few changes. It is therefore the most conservative human culture known. The hand-axe itself is a kind of universal instrument: it can be used to cut, scrape or bore. The long duration of the hand-axe culture can be explained only on the assumption that the hand-axe was originally evolved by a small and progressive group of mankind, and that the rest kept on unthinkingly copying it. This no doubt has something to do with the almost universal distribution of the hand-axe culture throughout the Old World. It is known from the British Isles to South Africa, from Portugal to Java. In some areas hand-axes are very plentiful, in others—for instance, in Germany—they are rarer, although even there they are not entirely lacking.

People have always racked their brains over what type of men made and used these hand-axes. No implements were discovered at the celebrated sites where primitive man was found at Mauer, near Heidelberg, and Steinheim; and hand-axes are lacking in the cultures of Peking man and *Pithecanthropus*.

Unfortunately, many of the sediments containing hand-axes have been so lixiviated that all organic remains have been destroyed. In India, near Madras, there are old river terraces that have been transformed by the tropical weathering into a viscous red clay known as laterite; in this clay lie many

43 Triangular hand-axe of Late Acheulian type from the sands of Swanscombe on the Thames estuary

hundreds of hand-axes made from quartz that have survived everything.

But at three separate localities human remains have been found in association with hand-axes. The most recent of these finds was at Ternifine, not far from Algiers, where during June and July 1954 Professor Arambourg of Paris unearthed from levels containing very primitive hand-axes two human mandibles that he attributed to a new genus and species—*Atlanthropus mauritanicus*. The jaws are strikingly large with coarse teeth and are most nearly analogous to those of Peking man. No detailed description has yet appeared.

In 1953 the skull of a Neanderthaloid, corresponding in many

respects to the Javan *Homo soloensis*, was disinterred at Hopefield, near Capetown, together with hand-axes of a finer type. There is no published description of these finds either.

Finally, there are the finds made in 1935 at Swanscombe, between Gravesend and Deptford. Here, in a raised terrace of the Thames, together with very finely dressed almond-shaped hand-axes, were found separated fragments of a juvenile skull, consisting mainly of the occipital sections; the brow is unfortunately missing. This is probably a modified Neanderthaloid, such as we know from Steinheim, that is no longer very far removed from modern man.

The hand-axe culture, which lasted in Europe till well into the last interglacial period, was followed by the Neanderthal culture, consisting almost exclusively of flakes. These tools dressed on one side only are termed by British and American archaeologists "unifaces". Here we meet a fundamental difference in technique, and we may presume that there was some underlying reason for this. An Amsterdam psychiatrist, Professor Bouman, thinks that the hand-axes may have been symmetrical so that they could be used as well with the left hand as with the right, and that the new technique with flakes was connected with a nascent right-handedness. This right-handedness was linked in turn with the development of the speech centres, so that behind this change in the method of working stone implements lies a psychological problem. Flakes dressed on one side only already occur in older levels, but they are exceptions. With the Neanderthaloid Mousterian culture, so-called from the Le Moustier cave in the Dordogne, these tools dressed on one side prevail. There is little differentiation in Neanderthaloid culture. It knows hand-points, scrapers and scratchers. Not until the emergence of *Homo sapiens* do we find a more varied range of instruments—spear- and arrow-heads, knives, scratchers, flat and hollow scrapers, borers, gravers, and very fine instruments that could be equally well used for cutting or tattooing. Now cultures follow one another

in rapid succession. After the disappearance of the Neanderthaloids and up to the end of the Ice Age, six or seven cultural stages are ascertainable in Europe that were not coexistent but successive. The oldest is the Aurignacian, called after the cave of Aurignac, also in the Dordogne. In Africa the equivalent of this European cultural phase is the Capsian, named after the village of Gafsa in Tunisia. The Capsian is widely diffused in the more recent deposits of East Africa, and sites are known from which hundreds of thousands of flakes have been recovered.

During our search of Oldoway Gorge, Leakey brought us to a spot far down by the river, where long Capsian blades and arrow-heads looking like segments of a circle were to be found. Geological observations leave no doubt that at roughly the same point as the Oldoway River cut its ravine in later times there was also a valley in the Late Pleistocene, which was subsequently filled in. This old valley-filling corresponds to Oldoway Level V, and was therefore deposited at the same time as the Capsian culture. This gives us the key to the riddle of the skeleton found by Reck, that looks so modern. The then inhabitants of the ravine buried their dead in the slopes of this old valley, at the height of Level II. Since the old valley-filling at this point has virtually disappeared, the skeleton lay practically on the surface, creating the impression that it came from the ancient Level II. In Gamble's cave, Kenya, Leakey discovered a splendid series of Capsian culture-levels containing human skeletons of the same type as that unearthed at Oldoway. Thus Oldoway man, though old, is not as old as was thought.

The huge quantities of implements at the African sites are an indication of how much at home man must have felt in this tropical paradise and how great his numbers must have been. We went out one Sunday to Olorgosailie, where we spent the whole day. The site lies right down in the Rift Valley depression, nearly 40 miles from Nairobi. Fairly recent movements

of the earth's crust have drained an old lake basin at this point; the strata lie at an angle and the surface has been eroded by weathering. Here Leakey found an area about 50 yards square on which more than 2,400 Late Acheulian-type hand-axes lay about on the ground. He found this accumulation of implements so remarkable that he left them as they were and built over them a raised platform, from which the terrain can be surveyed: every stone one sees is a hand-axe. Excavations have shown that there are more than twenty superimposed horizons here, all containing hand-axes of the same type. We must suppose there was a lake here that was very much smaller in the dry than in the rainy season, and that primitive men dwelt on its shores, following every change in the shore-line. Everywhere in the clay lie the bones of great beasts that were manifestly brought down by these hunters—elephants, far bigger than the modern African elephant, and huge hippopotamuses. All the bones have been broken in pieces with hand-axes, and the skulls, too, have been smashed, to get out the brains. The bones are always surrounded by a large collection of stone instruments. The astonishing thing is that neither at Olorgosailie nor at any other African site with hand-axes has any trace of fire been found, although charred bones or pieces of charcoal would undoubtedly have been preserved in these fine-grained sediments. It looks very much as though these men lived on raw food, as the Eskimo does today.

Since the study of ancient man began in Europe, and most cultural phases bear the name of a European site, one tends to think of Europe as the centre in which human culture developed. But the discovery of rich sites of Stone Age cultures during recent years in Africa—and all parts of Africa, in Cape Colony and East Africa, in West Africa and Somaliland, and even in the middle of the Sahara—leaves no doubt that Africa, too, was a culture centre of the very first rank. This is not surprising, for it took man a long time to adapt himself to the inhospitable climate of the Ice Age. It was only

some hundred thousand years ago that Neanderthal man reached the point at which he could winter in European caves, in order to hunt reindeer, mammoth and rhinoceros. Hence, as experience has taught us, there is no prospect of finding in the caves of Europe any human remains older than those of the Neanderthaloids.

Looking down into the Oldoway Gorge in the Serengeti Steppe, East Africa. Sediments of a Pleistocene lake basin

Fossil hunting with Dr Leakey
at Oldoway

Olorgosailie: every stone a hand-axe

EUROPE

The Sussex Forger

ON THE STAIRCASE of the Geological Society, London, there hangs—or, more probably, used to hang—a large picture painted just over forty years ago. Several earnest-looking gentlemen are sitting and standing round a table at which one of them, dressed in a white overall, is measuring a skull. The latter will be recognized by the initiated as Sir Arthur Keith, Britain's most celebrated anthropologist. Beside him stands Professor Elliot Smith, the well-known brain anatomist, and the palaeontologist, Sir Arthur Smith Woodward. Grouped round them is the whole staff of the British Museum (we can distinguish the round head of old Barlow, an unrivalled master among preparers), and in their midst, diffident and self-effacing, stands Mr Charles Dawson. The object that has brought him sudden world-wide fame lies on the table—the cranial remains of *Eoanthropus*, species *dawsoni*, so named in honour of its discoverer.

Eoanthropus dawsoni, or, as it is generally called after the site at which it was found, Piltdown man, was the subject of a first-class scientific controversy. Its remains came to light in a small gravel pit near Piltdown in Sussex, about half-way between London and the coast. Mr Dawson, a well-known amateur archaeologist, claimed to have been given the first fragment by a workman; the rest were found by him and Sir Arthur Smith Woodward of the British Museum, who had come down at his request. Between 1909 and 1912 nine skull-fragments were discovered that could easily be fitted together to form two half-crania; since they did not meet at any point, however, reconstruction was exceedingly difficult. The skull has a high forehead; its cranial capacity (depending

upon the reconstruction) is in the neighbourhood of 1,350 c.cm.; it clearly belongs to a *sapiens* type, and really its only primitive feature is the thickness of its walls (over 10 mm.) —but equally thick skulls regularly occur today, for instance among Negroes in Surinam (Dutch Guiana).

46 The skull and lower jaw of the Piltdown "Eoanthropus dawsoni", now known to have been a clever forgery (from an old British Museum guide-book)

The mandible recovered from the same strata in 1912 did not go with this cranium at all. It has no chin and so closely resembles an ape's jaw that soon after discovery it was described by some anatomists as belonging to a chimpanzee. The region of the canines is damaged, so that it is impossible to say whether these teeth were large or small. This man with an ape's jaw

caused a furore. Fossil human remains are just as rare as those of apes: could the skull of a man and the jaw of an ape have lain side by side in the same stratum? Most people considered this unlikely and accepted the connexion between the finds. But doubters remained. A pupil of Weidenreich's wanted to assign the mandible to a new ape, *Boreopithecus*, the "Northern Ape". Weidenreich compared it in the first place to the orang-utan, because, like the latter, it lacked certain muscle-attachments on the under margin of the jaw.

A tooth unearthed at Piltdown by Father Teilhard de Chardin in 1913 caused the same feeling of uneasiness as had the mandible, when it came to judging it. Teilhard, incidentally, is the only person—apart from Dawson and Sir Arthur—who found anything at the site himself. The crown of the tooth is severely worn, and there was argument as to whether it was an upper or a lower canine. The British tended to regard it as a lower canine (and fitted it into the lower jaw); the Americans took it for an upper canine.

All the finds seemed to derive from a very old level, since it also contained tooth-fragments of an extremely primitive elephant. Most geologists assigned this stratum to the earliest Pleistocene, some—notably Osborn—even to the very Late Tertiary. Tertiary man a *sapiens*! It only required a slight alteration in the jaw to produce the fully human type.

Apart from Piltdown man there was a whole series of allegedly very ancient *sapiens* forms, none of which, however, possessed such a simian jaw. The Foxhall mandible, which already has a chin, is said to have come from deep in the Red Crag on the East Anglian coast. Then there is the complete skeleton from Galley Hill near Northfleet in Kent, the finds at Denise in southern France, and various others. In the past there was no conclusive method of determining the age of skeletal remains. Since man is in the habit of burying his dead, human bones occur in strata of differing ages. In most cases, of course, it is not difficult to ascertain whether remains are those

of a modern interment or not. But there are finds that remain doubtful, and these have misled certain anthropologists into ascribing a very great geological age to *Homo sapiens* as such. This is naturally very important for the interpretation of our evolutionary history; for if we really go back unaltered and conservative to the Tertiary, then all the forms of primordial man discovered up to the present are merely parallel forms, interesting in themselves but without any bearing on the history of our own stock.

Hence Piltdown man, more than any other find, introduced an element of uncertainty into our ideas on the course of human evolution; and anyone who takes the trouble to read several books on fossil men will see to his horror that practically every author holds a different view as to the connexions between the known human forms. It is tempting to take refuge in the theory of "parallel evolution", according to which *Homo sapiens* is derived direct from *Eoanthropus* ("Dawn Man") and all other early hominids are simply "collateral forms".

Not until after the Second World War did Dr Kenneth Oakley of the British Museum evolve a method by which the true age of such questionable finds could be established. There is always a small quantity of fluorine in the ground-water, and this combines with the calcium of the bones to form a chemical compound the structure of which is dependent only on time. This means that all bones that have lain the same length of time in the same stratum must also possess the same fluorine content. None of the old *sapiens* remains stood up to this test: they all proved to be younger than had been supposed, thereby withdrawing from the evolutionary race.

When the fluorine test was applied to the Piltdown finds, the fluorine content of the bones turned out to be so small that they could not possibly be as old as had previously been assumed. With some doubt they were at first assigned to the youngest Pleistocene. This only rendered them all the more

puzzling, however. The existence of a man with a large cranial capacity but still in possession of a simian jaw was conceivable in the Early Pleistocene—in the Late Pleistocene it was an impossibility. Added to this was the fact that no such mandible had occurred at other fossil localities: the Chinese and Javan jaws are of quite a different shape. They are not in the least simian: they are primitive, but human.

Thus Piltdown man did not fit anywhere into the picture of the descent of man afforded by the more recent finds. One day the British anthropologist Weiner was struck by the fairly obvious thought that *Eoanthropus* might be a forgery. Scientific detective work began. The nitrogen content of the bones was determined, since this is high in modern bones and very much lower in fossils. A modern bone contains 4·1 per cent nitrogen, a human bone from a Neolithic grave 1·9 per cent, although it is only a few thousand years old. The notorious Piltdown jaw showed 3·9 per cent, the bones of the skull 1·4–0·6 per cent. This proved at last that the mandible did not belong to the cranium, and moreover was quite modern. Under the microscope it could be seen that the teeth had been filed down. The masticating surface was too smooth and the lines of the file were still visible. It was clear that this was a modern ape's jaw from which the canines had been removed and the molars filed flat, to produce a chewing surface such as only occurs in man. In other words, it was a skilful fake.

The canine tooth had been treated in the same way. Considerable surprise had been caused from the beginning by the fact that it still possessed an open root cavity (a sign that it came from a very young individual), while, on the other hand, it was completely worn down like a very old tooth. Here, again, the grinding surface proved to have been filed down, and the root cavity filled with some heavy mineral grains. In fact, the chewing surface had accidentally been filed through to the pulp cavity. When a living tooth is worn down as far as that, it automatically forms secondary dentine at this point;

and there was no sign of this in the X-ray picture. The canine was a no less cunning forgery than the jaw.

The origin of the cranium has not yet been explained. It owes its beautiful rust colour, like the mandible, to treatment with potassium dichromate. Now, Smith Woodward himself wrote that Mr Dawson had treated his first find with potassium dichromate to harden it. This is certainly a very queer procedure, since this medium is never used in the preparation of fossils. On analysis it transpired that the skull remains found by Smith Woodward had also been pre-treated with potassium dichromate, which seems to place the whole fraud in a particularly ugly light.

Sir Arthur Smith Woodward was so convinced of the significance of Piltdown man that he had a small house built at Haywards Heath, not far from the site of the find, so that he could always keep an eye on it. He was a man with a strong sense of fair play, and when he felt he had been passed over on the occasion of a promotion, he left his beloved British Museum, never to set foot in it again. From now on he dedicated his whole life to Piltdown man. When we visited him at Haywards Heath in 1937 he talked of nothing else. Sir Arthur wore side-whiskers and had eyes that sparkled with *joie de vivre*; he strongly reminded me of the old painter Hans Thoma, whom I often used to see during my youth and who made a deep impression on me. In spite of the bad weather, we had to go out in a taxi to the site of the discovery. Standing under a big umbrella, Sir Arthur showed us the spot at which he had unearthed the celebrated find.

Mr Dawson died, honoured and renowned, in 1916. After his death nothing else was ever found at Piltdown. It is certainly not nice to accuse a dead man, who cannot defend himself, but everything clearly points to his responsibility for the forgery. Indeed, it has now turned out that neither the fossils nor the tools belong to this locality at all, and that the whole find was carefully planted.

Why didn't we notice all this sooner? The widespread acceptance enjoyed by Piltdown man was bound up with certain theoretical conceptions published at the time of its discovery. Which came first, the hen or the egg? His studies of the brain had led Elliot Smith to the conclusion that at a very early stage in his evolution man must already have possessed a large and typically human cranial capacity. This theory has long since been refuted. We have seen that *Pithecanthropus* and *Sinanthropus* have a cranial capacity little greater than that of the ape—and yet they are truly human.

The unexpected collapse of Piltdown man is a great satisfaction to palaeontologists. Not only does it make man's genealogical tree simpler and more consistent, but it is now manifest that man's forerunners really are more primitive the farther back we go.

The Lascaux Cave

THE LASCAUX CAVE is situated in the Vézère Valley near Les Eyzies, where steep walls of rock drop down to the river and the slopes are honeycombed with caves and grottoes—the dwellings of Neanderthal man and his successors right down to the present day. Many a house in Les Eyzies stands beneath a ledge of overhanging rock, thus saving the necessity of building a rear wall.

The neighbourhood of Les Eyzies has always been a centre for prehistoric research. The culture of Neanderthal man is called Mousterian, after the Le Moustier cave. In 1908 Hauser recovered from this cave the complete skeleton of a Neanderthaloid, a young man of about twenty. This find was purchased by the Berlin Museum for a large sum before the First World War, but was unfortunately lost during the Second. The most recent culture of the Ice Age is called Magdalenian, after the cave of La Madeleine. All over the countryside surrounding this little town one may stumble on stone implements; for the

most part they are unimportant flakes, but occasionally one comes across finely dressed tools.

Cave drawings and reliefs also occur in the neighbourhood. There are the caves of Font de Gaume and Les Combarelles, discovered as long ago as 1901, and the magnificent bas-reliefs of Cap Blanc and Laussel.

At Montignac the landscape changes. The slopes are gentler and entirely covered by fields and woods. The discovery of the Lascaux cave was due to pure chance. Some village lads were out for a walk with their dog; while scampering about, the animal fell down a cleft and could not get out again. Going to its rescue, the lads discovered that the cleft was the entrance to a lengthy subterranean grotto whose walls, they observed to their astonishment, were decorated with drawings of horses, aurochs and deer. That was in 1940; it was not until after the war that the cave became widely known, when an artificial entrance was constructed, through which it may now be entered in comfort.

Today electric light has been installed and ventilation provided. Naturally, there is an entrance charge, and the patient herd of tourists are herded through the passages by guides. The guides are the same lads who first discovered the cavern.

Not much is left now of the sacred stillness. And yet there is something about this grotto that grips the visitor from the first moment of entry. This stems not only from the power and quality of the wall-paintings, but also from the remoteness of the place and its undisturbed antiquity, which is spoilt only by the new entrance.

This cavern was never lived in. There are no culture-levels with stone implements and osseous remains to be found in its clay floor. Man entered these grottoes solely to draw, and they were known only to a few initiates.

The mysterious darkness of the cave is a thing of the past. Electric lighting blazes pitilessly down over the smooth rock

walls that are covered with innumerable depictions of animals. There are aurochs, bison, a multitude of horses. A group of deer seems to be just swimming a river; only the raised heads with the proud antlers are visible. A huge fabulous monster, fat-bellied, with circular spots and two straight horns, is watching over a herd of horses and cattle—the only figment of the imagination among all the realistic animals.

Some of the representations are (in all, five hundred or so) painted in areas of colour; others are simply drawn in outline. As so often happens with cave drawings, the artists had no compunction about working on top of older paintings, the result of which is frequently a surrealistic confusion of animals' heads and bodies. The drawings not only testify to particularly acute powers of observation that must have been inborn in the hunter, but also bear witness to a powerful artistic inspiration and a deep earnestness that we cannot claim to have grasped if we describe these drawings as merely beautiful, strong, impressive, gripping and skilful. Most of us have seen so much art, without being artists ourselves, and are so used to passing judgment as soon as we look at a work of art that it is not easy for us to take in the tragic seriousness of these pictures.

For these drawings and paintings are beyond all criticism. Man's discovery that he could transmute his emotions into artistic creation was of the same fundamental importance as the invention of writing. He creates something that is more efficacious than his desires, more real than his thoughts, something that endures and acts even when he is no longer there, something that his fellow-men (and why not also the spirits that surround him?) must be able to appreciate and understand.

These cave drawings are sacred and consecrated, even if they only depict animals. In Ice Age art representations of man become very infrequent, and when they do occur the portrayal is in the nature of a caricature, although it is the work of the same men who could depict animals with a realism unparalleled

by any modern artist. The only other animal representations which can compare in intensity are the Bushman drawings of South Africa and some Japanese and Chinese paintings. If, therefore, Ice Age man shunned the portrayal of himself there must have been some special reason for this.

It is easy to forget that primitive man has only an imperfect idea of his own appearance, since he possesses no mirror. At most, he may occasionally see himself reflected in a spring or some other water surface, but then his reflection is as much alive as he himself. This may be the source of the widely held belief that anyone who possesses a man's picture can also exercise power over his person. This, in turn, may readily give rise to the notion that the lifeless model of a man can be brought to life—an idea that finds terrifying expression in M. W. Shelley's story of Frankenstein's monster. The magical power of a portrait has also found literary expression—in Oscar Wilde's *Picture of Dorian Gray*. Here the portrait alone grows old, while the subject himself remains young and unchanged.

As a student at Munich I had a Caucasian friend who had become a painter, although he came from a Mohammedan family and his religion forbade him to make representations of animals or men. He once told me how he had given an old teacher, for his seventieth birthday, a picture illustrating a scene from an ancient legend. The old gentleman, although visibly embarrassed, did not like to refuse the gift. But at dusk he appeared at my friend's house with the painting under his arm and explained that he would be glad to keep it, but on one condition: my friend must first cut the throat of every human figure on the picture with a razor, so that no one could bring them to life.

A brief reconstruction of the history of art will show us that Neanderthal man was apparently not mentally capable of artistic work. When the early *Homo sapiens*—that is to say, a representative of our species—first began to express himself artistically some 60,000 years ago, he started with things he

could grasp, with little figurines in three dimensions. Representations of animals are very rare; on the other hand, little statuettes of amply proportioned women, often naturalistic but sometimes highly stylized, are widely distributed throughout Europe and Asia. The most famous statuette is probably the *Venus of Willendorf*, from a site in Lower Austria. The significance of these female figures is obscure. They have been sententiously interpreted as fertility idols or mother goddesses, but none of them has ever been found in circumstances from which a special cult could be inferred.

Little clay figures not dissimilar from these "idols" are met with among South American Indians—but they are merely children's toys.

In the *Willendorf Venus* the body is realistic, with fat thighs and enormous breasts which are only accentuated by the thin little arms laid across them; but the head is simply a bee-hive without the least hint of nose, mouth or eyes. In the *Venus of Lespugue* in France, which is carved from mammoth ivory, the body is stylized and even more exaggerated—which gives it a thoroughly modern and contemporary look—but the head is an expressionless egg. The little female head from Brassempouy has a nose, but neither eyes nor mouth. In the human figures from Laussel—bas-reliefs dating from a rather later period—the face is also a blank. It is as though any resemblance to a portrait had been intentionally avoided; above all, the eyes, that could have seen everything, have been omitted.

The magic power of the eyes plays an important role among many peoples. We need only think of the "evil eye" and the various amulets worn as a protection against it. In ancient Troy, bowls were decorated with an eye motif as a defence against evil spirits; and when the modern Javanese—under the influence of the Moslem religion—attempts to stylize his traditional knife handles, which represent giants or occasionally lemurs, it is generally the eyes that are covered with ornaments, or simply left out. A planter in West Java, who had dismissed his native

housekeeper, once showed me his photograph album in which the young lady, before leaving, had carefully stuck a needle through the eyes of every photograph of her former master.

All these may be reasons why the human figure was so strongly stylized. For it is clear from all the coeval realistic portrayals of animals that, even at this early stage, man was perfectly capable of achieving verisimilitude in art.

The Ice Age did not end with the gradual dying away of a cold period. It disappeared in bursts: after the peak of the last great fourth glaciation, in which Neanderthal man held the field, it first became rather warmer, and then the cold returned. And when it became glacial again for the last time, the artist changed his technique and also his choice of models. He moved from sculpture in the round, via a brief transitional phase of bas-relief, to flat drawing. He abandoned three dimensions for two, although a few sculptures continued to be produced. Man had learned something he never again forgot.

As may be seen, the earliest sculptures consist predominantly of representations of humans, and almost no animals; in the drawings, animals preponderate and man occurs much less frequently. The animal must once more have come to play a greater part in human life, and the reason for this is to be found in the unfavourable change in the climate. The summers, providing berries, fruits and roots, became shorter, the winters harsher and longer; therefore hunting became increasingly essential to life. To keep his family alive, the hunter must be successful at all costs. The aurochs must be fat and the wild horses plentiful, the animals must flourish and multiply, all to provide him with food.

We have already seen why the representation of living beings as such possessed a magical significance, and now we can understand why such a positively exaggerated realism appears in the portrayal of animals. Here the hunter's prey was to be bewitched in a figurative way by means of its image, for without his prey the hunter could not live. Behind these

drawings lies a deadly serious purpose: that is why they were carried out in such a hidden place. This is a sacred art, even if it depicts only horses, deer, bison and other beasts. It is easy for a person who has never gone hungry to look down on other people's "materialism". Even modern man, who can go out and buy bread, meat, fruit or preserves in any shop, begins his prayer: "Give us this day our daily bread. . . ."

If we look at the animal pictures rather more closely, we discover surprising details. Pregnant animals appear again and again; others are shown pierced by spears or arrows; and between the animals we note curious geometrical figures that are thought to symbolize pitfalls and traps. Everything bears upon hunting, and representations of men wearing animal masks reveal that these drawings were not the only form of hunting magic. In the Trois-Frères grotto we find a man wrapped in skins and wearing stag's antlers on his head. Gazing at the spectator with round, staring eyes, he seems to be executing a magic dance. Other wizards have crept into a bison skin. On a small piece of bone from another cave we can distinguish men disguised as chamois. Animal masks or disguises must have been used not only in dances but also while stalking game, as the South African Bushmen do to this day.

From rock drawings and engravings on flints, bones, reindeer horn and mammoth ivory we know pretty well the whole Late Ice Age fauna with mammoth, reindeer, deer, bison, aurochs, ibex, chamois, bear and lion down to seal, salmon and eel. Almost all the animals are shown in isolation. Scenes drawn from the hunt or ritual are rare, so are groups. The herd of swimming deer at Lascaux, or the birdman and his victims and audience at Addaura, are exceptions. Drawings that tell a story or illustrate an experience, such as are known chiefly from northern Spain, all date from the post-glacial epoch, when the climate was more genial.

Ice Age art is clearly magical in origin, which does not, however, exclude joy in what is beautiful and aesthetically

pleasing, even at this early stage. Just as delight in technical ability is manifest in the finer implements of the Late Palaeolithic, so the forms (e.g. the cow bison with head turned back at Altamira) and colours employed in the rock-paintings reveal elements that go beyond utilitarian magic.

It is striking, but, in the light of what has just been said, understandable how rapidly art lost its verve at the end of the Ice Age, when the climate improved and living became easier. It had been born of a deadly seriousness; it blossomed despite —no, precisely because of—material hardship and the urgent search for food, and it faded when the ice retreated and the sun grew stronger.

Ice Age art reveals man's outlook on life, on his own day-to-day existence. But with two exceptions, it tells us nothing about his attitude to death and eternity. Here we must turn to other sources for our knowledge.

We have already seen that Peking man was a cannibal and Solo man a head-hunter. Both ritual cannibalism—it cannot have been anything else here, since game was available in plenty—and the practices of head-hunters are rooted in magic and religion and are signs of man's spiritual awakening, even though their precise significance is hard to establish.

At all events, the skeleton cult appears at a very early stage; whether it already led to ancestor worship among prehistoric men we do not know. Every phase is still displayed by living primitive races. Preservation of the skull, regarded as the dwelling-place of the spirit that would otherwise wander about, is the most primitive phase. The skulls of members of the tribe are gathered together and preserved at special places. In New Guinea, in the great men's houses on the Empress Augusta River, the skulls are coated with resin or clay, out of which the dead man's likeness is modelled on the skull. In Celebes and the Philippines the skulls are deposited in remote caves. On the Andamans, a group of islands north of Sumatra, the widow used to carry her dead husband's skull about with

her for the rest of her life. To the tribe's own skulls are added those captured from outsiders, which are credited with special magic power.

Some primitive peoples try by various crude methods to mummify their dead. Because of the damp atmosphere of the tropics such attempts rarely succeed. When mummification is replaced by sculptural representation of the dead man, the first stage is a body carved in wood that carries the actual skull. The finest extant examples of this are the *korvars* of western New Guinea—small squatting or standing wooden figures with huge heads containing the real skull. Sometimes we find simply a platform or open container instead of the head. A step farther, and the ancestral figure is born.

No ancestral figures are yet known from the Ice Age. But in the Montespan cave in the French Pyrenees the effigy of a bear was found, the body of which was modelled in clay while the head was a genuine bear's head or skull. The ideas at work were therefore of the same order.

We know nothing of any pre-Neanderthaloid cult of the dead. All the Javan finds of the *Pithecanthropus* and *Meganthropus* groups were recovered from river sediments, into which they had come by chance, so that they furnished no clues in this respect. Peking man seems to have buried his dead; interment first occurs among the Neanderthaloids. The classic skeletons of Le Moustier and La Chapelle lie in a sleeping posture; the La Ferassie Neanderthaloid shows the squatting position with drawn-up legs that becomes widespread in the more recent levels and continues into the European Bronze and Early Iron Ages. Cremation does not appear until after the Ice Age.

Much has been written about this squatting posture in prehistoric burials. Many writers have supposed that the intention was to entrust the dead man to the earth in the same position he occupied in the womb. Some of the squatting dead seem to have been tightly bound, perhaps to prevent their return into the world of the living. Perhaps the squatting

position merely represents a primitive resting posture, such as may still be seen among many peoples. The Javanese, for instance, prefers to squat rather than sit down on the ground, and he relaxes in this position that seems so uncomfortable to a European.

Neanderthal man buried his dead in shallow graves without any special protection. The early *Homo sapiens*, in Europe Cro-Magnon man, was the first carefully to cover the grave with stones. Were these intended as a protection against hungry beasts of prey, or to prevent the dead man from returning?

That the Neanderthaler believed in life after death is proved by the carefully selected grave furnishings. The dead man was given not only his best weapons but also food for his long journey.

To represent the soul as a bird that may fly away at any moment is a deeply felt symbol of the transitoriness of life with which even the Christian religion cannot dispense. We meet it among many peoples. It appears for the first time in the Lascaux cave, where, among all the representations of animals, there is one single portrayal of a man. It is situated in an almost inaccessible place, hidden from the eyes of the profane visitor, namely in a pit. And here the man is not depicted alone, but as the central figure in a scene. We see a bison with lowered horns. He is wounded; his entrails are hanging out of his body. It is a magnificent picture, painted with coloured surfaces. In front of him, lying helplessly on his back with outspread arms, is a man. He is portrayed in outline only and looks like the clumsy drawing of a child—almost a caricature. We have already seen why realistic representations of human beings were shunned. The bison is pierced by one spear, and another lies below him on the ground. The scene is perfectly clear: a wounded bison has attacked and wounded his hunter.

But this is not all. Beside the hunter stands a stake on which sits a bird, also drawn in simple outline. Taken in conjunction

with the whole situation, this can only be construed as a soul-bird. We are confronted here by the most ancient known portrayal of a soul-bird. Why the latter is perched on a stake cannot be explained. Perhaps it was represented as tied to this stake to stop the hunter's soul from flying away.

In Indonesia we encounter the soul-bird in many guises. When rice is cast at a newly wed couple—a custom that has become established also in Europe and America—real food is being provided for the symbolic soul-bird. Almost no genuine Javanese household is without a little dove in a cage, that is hoisted up like a flag on a long pole beside the house on fine days. People observe this dove closely and regulate their lives by it. "I knew I could expect a pleasant visit today; my dove cooed so beautifully," I was once told by a Javanese whom I had called on. A Borneo Dyak will abandon his hunting expedition and return home if he sees a bird of misfortune on his left hand.

When a Javanese shadow-play, a *Wayang Kulit*, with its strictly stylized leather figures—good Mohammedans are not permitted to reproduce the image of a person, but only to portray his character—is performed after sunset, and the souls of the dead heroes in the drama come to life, the lamp is always shaped like a great bird from whose breast the fire comes. These *Wayang* lamps, called *blintjong* in Java, are very heavy and hang from the ceiling on a chain. They are given a slight push before the beginning of the shadow-play, so that they swing to and fro a little. This causes the shadows cast by the leather figures, which are seen on a white cloth with a red edge—the *kelir*—to move ceaselessly, as though they were really alive.

Those who take part in the ceremonial dances and performances often wear, in addition to the sacred masks, curious hats and a multitude of ornaments and amulets on ears and breast. The breast ornaments frequently take the shape of a bird, or at least of a bird's head. Every now and then one comes

across a more realistic dance hat that has clearly retained the shape of a bird; the fantastic ear ornaments are then seen to be nothing else than the soul-bird's somewhat displaced wings. In many cases they are all that is left of the bird, once the original shape of the headgear has vanished beneath gilt edges and other trimmings.

45 Despite its stylization, the soul-bird is still recognizable in the head-dress of a Javanese dancer

Many of the old wooden and stone figures in Java and Bali still wear a small bird-mask in the hair at the back of the head to ward off evil influences attacking them from this direction. This mask is still often to be seen on shadow-play figures. Many oil lamps and candlesticks likewise take the form of birds, for one has to be particularly careful in the dark. In eastern Indonesia ancestral figures are often distinguished as such, and raised out of the sphere of everyday life, by the addition of birds' wings. In the fine carvings of Timor Island

the ancestor is often seated on a bird and surrounded by birds. Frequently, indeed, only the birds are represented realistically, and their beaks form the outline of a stylized human figure. On the ancient cloths of Sumba Island not only the human beings but also the animals are portrayed with their soul-birds —horses, crabs, fishes and even the birds themselves. The symbolism of the soul-bird can be traced across the whole wide area of the Pacific, from the bird-beaked ancestral figures and masks of New Guinea to the sacred feather-cloaks of Hawaii and the mysterious bird-man of Easter Island.

Man awakens slowly. Skull-hunting and cannibalism with their magic implications go back more than 300,000 years. It is 100,000 years since Neanderthal man buried his dead with solemn dignity. How old, then, is the soul-bird of Lascaux?

No stone implements have been found either in or in front of the cave. The animals depicted indicate a fairly temperate climate: mammoth and reindeer are missing, and the rhinoceros occurs only once. Since a few years ago it has been possible to establish very exact dates for material from the not too distant past with the aid of radioactive carbon, C14. A piece of charcoal left behind in the Lascaux cave by Ice Age man was analysed in Chicago. It gave an age—with a margin of error of about 900 years—of 15,516 years.

EPILOGUE

The Human Family

WE HAVE MADE the acquaintance of the most important types of ancient man, and met the half-men from South Africa and also *Proconsul*—the most important representative of the early anthropoids. In conclusion, we will try and establish man's position among the Primates, as it appears to the palaeontologist. To do this, we must return to the family tree as the simplest means of expressing the position diagrammatically.

Many people would probably accept man's descent more readily if he were the only representative of the Primates and his primitive forerunners, fossilized and unreal, were lost in the distant geological past. But it does not happen to be like that. The Primates still form a flourishing group: against one species of man we have to set three anthropoid apes and over 250 species of Old World apes—amongst the latter the mandrill, the most colourful of all mammals. In no other group do we find such extremes; it is as though nature wished to bring home the peculiar significance and responsibility of being human by setting beside us so many animal members of our family.

We are thus in the fortunate position of being able largely to supplement our scanty fossil finds by observing living Primates. And we soon see that, as was to be expected, the most primitive families are also the oldest, and that the living representatives differ from the fossil forms in varying degrees.

To begin with the lemurs: we find in the rat-sized, tree-dwelling South Asian koboldmaki or tarsius the form that most nearly corresponds to the original type from which the higher apes sprang. It resembles the latter in, for example, the structure of the bony orbits, that are closed at the back, and

Skull trophy of the Dyaks of Central Borneo

Ancestral figure (*tiki*) carved out of a human bone. Marquesas Islands

A skull *korvar*, ancestral figure from New Guinea

Skull with face modelled over it and decorated with genuine hair. New Guinea

of the placenta. It has diverged somewhat from the primordial tarsius by over-specialization of the hind legs and other features, but this is of no consequence here. Without anatomical examination of the living tarsius the significance of the fossil ones, which are poorly represented, would probably have escaped us. We should then have failed to observe the evolutionary potentialities of the type as a whole. These potentialities cannot be predicted; they can only be recognized when they have actually come into being.

There are plenty of examples of this, from which we will take one. In 1840 Owen described some fossils recovered from the Early Tertiary "London Clay" of southern England. Amongst them was a small mandible-fragment with two teeth which he compared to that of an ape—a sensational idea in those days—as well as the skull of a small animal that seemed to be intermediate in character between a pig and a rock-badger. "The large size of the eye, indicated by the capacity of the orbit," wrote Owen *inter alia*, "must have given to the physiognomy of the living animal a resemblance to that of the Hare, and other timid Rodentia."

Today we know that the supposed ape's mandible and the skull belonged to one and the same animal. Despite the fact that it was the size of a large hare and had four toes on its forefeet and three on its hind feet, this was a hyracotherium —Europe's most ancient horse. It was the ancestor of the (unsuccessful) group of European horses that reached their culmination in the tapir-like, three-toed, rhinoceros-sized *Palaeotherium magnum* from the Montmartre gypsum in Paris. The American group begins with the equally small proto-horse, *Eohippus*, and leads through a completely known series of ever larger intermediate forms to the present large and single-toed horse.

We recognize this *Eohippus* in a drawing by the famous zoologist Thomas Huxley, who invented an "Eohomo" to go with it. There is a slight misunderstanding here—but, then,

perhaps the drawing was only meant as a joke—for at that time there was no sign anywhere of man in his present form. At this period—about 50 million years ago—man was still at the tarsius stage.

The three groups of living lemurs, of which our tarsius is one, had already separated at the time of *Eohippus*. The second

46 "Eohomo on Eohippus"—a drawing by Thomas Huxley (after Romer). The primitive horse *Eohippus* really existed; the primitive man "Eohomo" is an impossible figment of the imagination

group comprises the ordinary lemurs, many species of which inhabit Madagascar while a few forms extend to Africa and southern Asia. The third group has only one highly specialized representative. This is the shaggy aye-aye of Madagascar, whose Latin name is *daubentonia*. Its incisors are so much like a rodent's that it was at one time mistakenly placed among the rodents. The hands of this creature are characterized by their exceedingly long and very slender and mobile third finger, which it uses to pick out grubs and worms from their holes under the tree bark. Fossil lemurs and daubentonias occur in Europe and America.

Shortly after the appearance of the first horses—or, rather, of the first horse-like creatures—there must have branched off from the tarsius stem a further powerful stock, to which the

majority of the higher Primates belong. Around the beginning of the Late Tertiary, about 30 million years ago, this seems to have split up into three fresh lines.

Of these, one leads to the Catarrhini ("narrow-nosed"), or Old World monkeys, which include the ordinary macacos and long-tailed monkeys, and the baboons and mandrills. The many species of South American Platyrrhini ("broad-nosed"), or New World monkeys, of which we will name only the howling monkeys and the sapajous, are most probably derived directly from North American lemurs—so that the two groups of "apes", although naturally both Primates, have very different origins. The Old World monkeys most probably originated in Africa—in all likelihood, East Africa.

The next highest form is the gibbon, several species of which live in South-East Asia and are not rare in Java. It shares with ordinary monkeys the ischial callosities, or bare patches over the buttocks; but its dentition and anatomy are closer to those of the anthropoids, among which it is sometimes numbered. It lives in the tree-tops, swinging by its extremely long arms; because of its mode of life it is very restricted in size. Its origin has not yet been traced. Small fossil anthropoids—e.g. *Pliopithecus*, whose remains have also been found in Europe—have repeatedly been claimed as its ancestors; but increased knowledge of their skeleton has shown that these species show no signs of specialization in the direction of the living gibbons. The latter must have split off from the anthropoid stock around the beginning of the Late Tertiary; forms with a "gibbonoid mode of life" probably branched off on several different occasions, so there is not necessarily any direct genetic connexion between the various groups.

Now we come to the anthropoids or man-apes, which—as anyone can see for himself in the Zoological Gardens—are fully entitled to their name. Of the three extant representatives, the gorilla is bigger than man. An adult male weighs more than 4 cwt. The anthropoids probably belonged to a single

group, from which the orang-utan broke away first, and later the gorilla and the chimpanzee.

A great deal has been written about the relationship of the anthropoids to one another and to man; there is no space here for a detailed comparison. Adolph H. Schultz, now professor of anthropology at the University of Zurich and one of the leading experts on the living Primates, made a complete list of the characteristics of the various anthropoids and man, comparing weight and stature, number of vertebrae, size of torso, etc. Taking 57 specific features, starting with man (57), and working out the degree of similarity, he found that the gorilla came first with 23, followed by the chimpanzee with 12, and the orang-utan with 7. It must be admitted that not all the features are of equal value, nevertheless these figures give us some idea of the degree of resemblance between man and his closest animal relatives. Incidentally, the characteristics are very unevenly distributed: for example, the orang-utan's dentition differs most widely from man's, while its brain shows the greatest similarity.

Until we know more of the immediate prehistory of the extant anthropoids (up to the present, the orang-utan alone is documented by a few isolated teeth) little can be said about them from a palaeontological point of view. Of the *Proconsul* group, which lived in East Africa at the beginning of the Late Tertiary, we may assume that it dates from a time when man and the anthropoids were not yet divided.

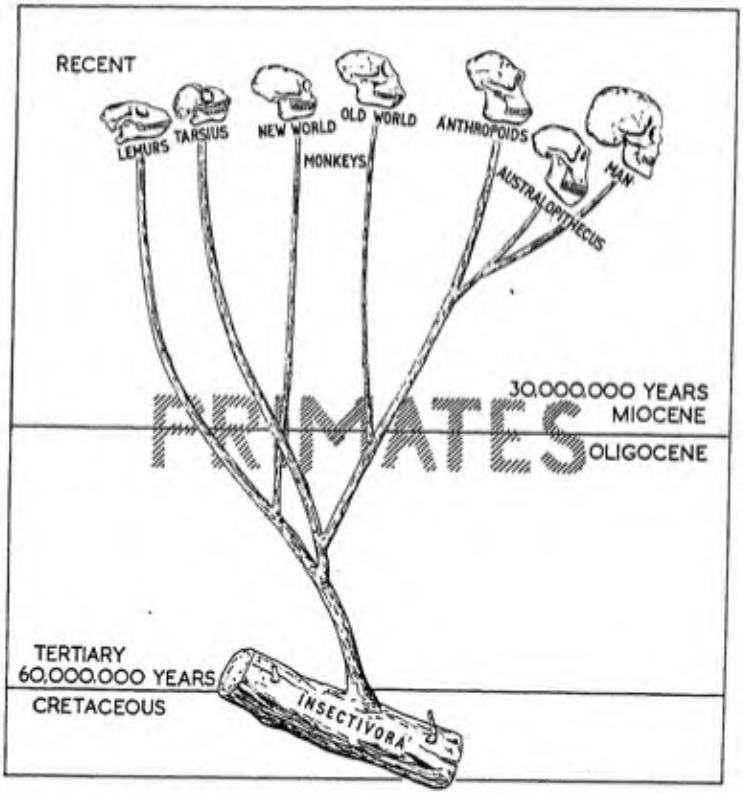
This brings us to a difficult point. The unmistakable anatomical correspondence between man and the anthropoids clearly points to a common ancestor. This ancestor, measured by present standards, was naturally neither a man nor an anthropoid ape, but merely a higher Primate with great evolutionary potentialities (think of the proto-horse). When did this form live, and when did our ways part? On this question the opinions even of well-known specialists differ widely. Thus Osborn and Sir Arthur Keith suppose the split to have taken place in

the Early Tertiary; Gregory and others around the beginning of the Late Tertiary; and Weinert sees men and chimpanzees parting company shortly before the beginning of the Ice Age! The latter view, quite rightly, has met with vigorous opposition. I myself believe that the beginning of the Pliocene era —about 10 million years ago—was the critical period for the coming of man, for here may be observed extensive changes in the mammalian fauna and the gradual emergence of the modern types.

The differences between man and the anthropoids are great, but even greater are those between the latter and the ordinary apes. To underline this, Simpson—in 1931—grouped the family of man and the families of the anthropoids into a super-family which he called "Hominoidea". There is no need to stress the fact that we have no direct links with the living anthropoids. The theory of an otherwise excellent, but on this point rather naïve, anthropologist that the Negroes are derived from the gorilla, the Mongols from the orang-utan, and the Whites from the chimpanzee, possesses only an historical interest. As we have seen, matters are not quite so simple as that.

The human group (in the widest sense) is distinguished from the anthropoids by—apart from different physical proportions, lack of body hair and a few other less important features—two main characteristics: erect gait, and an absolutely as well as relatively large brain. We find upright gait in the extinct South African australopithecines, which seem, however, to have been wanting in the disproportionate increase in brain size characteristic of true men. I have tried to present the genealogical relationships of the living Primates, as outlined above, in a highly simplified family tree—intentionally omitting the branches and sub-branches indicated by the fossil discoveries.

Upright carriage was bound to lead to numerous anatomical modifications. The hind limbs became powerful walking organs; the pelvis was tilted at a different angle; the spinal column acquired a new position; and the head no longer had



47 The family of the Primates. A highly simplified diagram of the descent of the living Primates; of the fossils only the supposed position of the South African *Australopithecus* group is given.

The order runs as follows:

1 Lemurs
2 Tarsius
3 New World monkeys
4 Old World monkeys
5 Anthropoid apes
6 *Australopithecus*
7 Modern man

to be held horizontal by powerful neck muscles. Most significant of all, however, was the effect on the hand, which was no longer used for support but mainly for grasping, and

developed into a sensitive, pliable organ with whose aid man can make tools, write letters, paint pictures and play the violin. The hand is not autonomous: it has to be guided by a dominant brain.

The brain is the most human of man's organs, the seat of his intellectual faculties, of his understanding, his knowledge and his memory. "The Greeks saw man as a rational animal, set apart from the lower orders by the uniqueness of his intellectual faculties. In the Christian view man is both flesh and spirit. To the modern naturalist he is 'Homo faber'—a tool-making animal. To the psychologist he is a talking animal, capable of feeling guilt. But to the evolutionist man is essentially a mammal with an oversized brain," complained Barnett in 1954. And he was not so far wrong.

Our brains! A little tea or coffee lends us wings, an excess of alcohol renders us foolhardy and licentious. Injuries to, and operations on, the brain may have grave consequences, such as loss of memory or speech; they may even bring about a complete change in the human personality. Unfortunate people with too little brain are unable to develop mentally out of their earliest infancy. None of man's organs is so sensitive or exercises such a profound influence on his personality and activity. Man is a cerebral animal. And yet the basic design of our brain does not differ from that of the anthropoids. But it is larger—a man's brain is about three times the size of a gorilla's—above all in the important frontal section; it has a greater surface, more convolutions and more and better developed centres.

The victory of man is a victory of the brain. This is not his special merit—it is a phenomenon that repeatedly occurs in nature. The mammal's superiority over the reptile rests upon a better differentiated, more receptive and more quickly reacting brain. We have seen that fossil man's cranial capacity was smaller than modern man's. *Pithecanthropus* had an average brain volume of about 900 c.cm., Peking man 1,050 c.cm.,

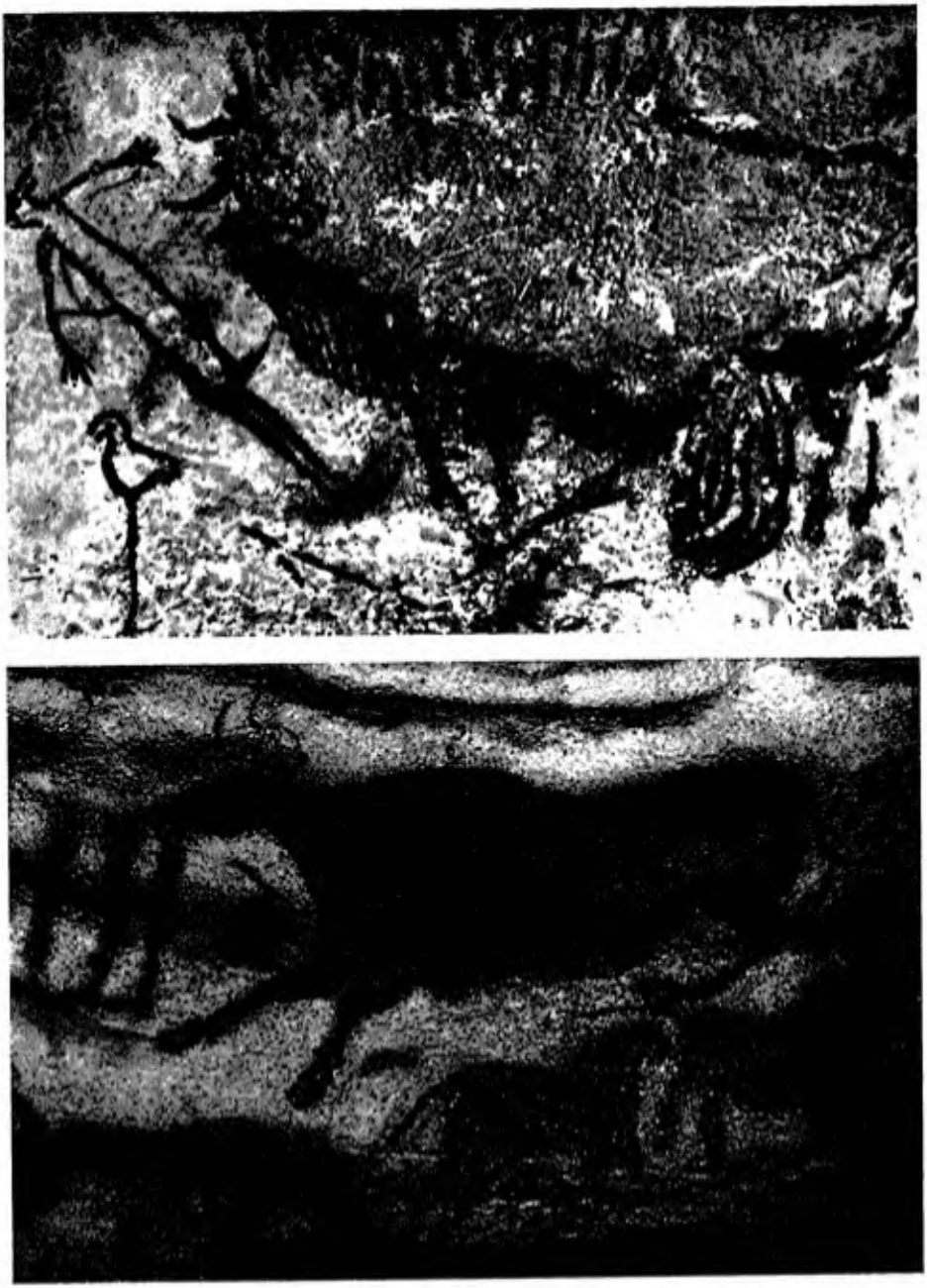
Solo man 1,100 c.cm., the modern European 1,350–1,500 c.cm. Intelligence, or rather the capacity for intelligence, must gradually have increased until at the last decisive phase in our modern evolution, writing—a kind of speech must have existed at a very early stage—made possible a prodigious intensification of the process.

The slow evolution to human status is mirrored not only in the physical sphere—the changing shape of the embryo is a case

48 Man's forehead as the mirror of his intelligence: *left*, Peking man; *centre*, Neanderthal man; *right*, modern man. All the skulls are in the same orientation (after Weidenreich)

in point—but also in the psychical. Thus Jung claims that the psychological development of the individual reflects the history of the race.

There are countless publications dealing with man and his anatomical peculiarities. Why did we become human? What enabled us to rise so high and see so far? In recent philosophical literature it is often said that man has not yet realized to the full his evolutionary potentialities and is still capable of unlimited development. This view is indefensible. Schultz, in the study referred to above, shows that of 82 comparable features man, compared with the higher Primates, has reached the highest level of specialization in 27; after him comes the gorilla with 17, followed by the orang-utan with 16, and the



Rock paintings at Lascaux in southern France: the animals are portrayed realistically, the man schematically and accompanied by a soul-bird (photo: Windels)

Even animals have their soul-birds: a large cloth (in *ikat* technique) from Sumba Island, Eastern Indonesia

chimpanzee with 6. Man is the most highly specialized Primate, and therein lies his strength.

We began this excursion into our past in Java. This was not because I happen to have worked and excavated there, but because Java is the region from which we know the greatest number of primitive types of man. Each of these forms may be regarded as the incarnation of a particular stage. First comes the *Meganthropus* stage; then the *Pithecanthropus* stage; Solo man belongs to the Neanderthal stage, which we ourselves follow at the *sapiens* stage. But when we try to assign fixed places to these forms in the human "family tree" we run into great difficulties. Anyone who reads a number of books on the descent of man is likely to find as many genealogical tables as authors.

To construct a family tree for man, such as can be done for the animal species, seems to me a fruitless endeavour. For the animal species are geographically circumscribed: they are adapted to particular climatic conditions, to a particular diet, to a particular environment. Once the various species are geographically separated they split up into races, which, after prolonged isolation, form new species no longer capable of interbreeding with the original stock. This makes it possible, in ideal cases, to trace one clearly defined species back to another clearly defined species.

Now, it is typical of man that he can live under all climatic conditions—in the tropics or in the cold north, in the plains or in the mountains. He can live on an animal or a vegetable diet. For him there are no geographical limitations. The higher Primates are fruit-eaters and consequently confined to the tropics, and early man must have led a similarly restricted life. Not until the invention of implements had made him a hunter did first the temperate, and later the cold zones open up to him. In Europe we can see how the caves remained empty during the first three Ice Ages, and man pushed up into Central Europe only during the warmer interglacial periods. With the

last Ice Age the situation changed, and from then on he settled permanently in the area.

The hunter's life, with its adventures and dangers, must have been of tremendous importance for the evolution of man. It was a touchstone of intelligence, courage and skill. The hunter had to be more resourceful, quicker and more adroit than the animal; and he also, perforce, excelled his vegetarian fellows in these qualities. In the animal kingdom the beasts of prey are more agile, crafty and cunning—and also smaller—than the clumsy, peaceful herbivores, which often live in herds. I consider it entirely conceivable that a heavy, massive jaw like that of *Meganthropus* belonged to a vegetarian type, while the more graceful, smaller jaw of *Pithecanthropus* belonged to a hunter; naturally, this cannot be proved.

Because of the nomadic existence of the hunting hordes, one group can seldom have remained isolated long enough to form a definite "species"; and even if this did happen and a group followed a particular line of specialization, which would have given it an "overspecialized" appearance, we have to reckon with the possibility of another population group invading the area and interbreeding with the previous inhabitants. In New Guinea we still find that, when two tribes wage war on one another, the victors kill and eat the men of the vanquished group and incorporate the women and children in their own tribe. Things must have been just the same in the past. This may have been the case with the Mount Carmel population of Palestine, where we find a mingling of *sapiens* and *neanderthalensis* types, with the women tending more towards the latter. . . .

We shall therefore do best to represent man's family tree as a funnel with its tip in the earliest Pleistocene, a funnel into which we introduce the finds of ancient man according to their geological horizon. We shall then see that, as in Java, the geologically older forms are generally also the most primitive. Hence there is no reason to assume diverse "racial stocks" or

any marked degree of "parallel evolution". When our knowledge of the various forms increases, it will probably transpire that the relationships between them can only be represented as a very complicated network.

Despite assertions to the contrary, we do not yet know any Tertiary man—and yet he must have existed. Perhaps we have already discovered him, but cannot recognize him as long as our material remains so sparse. A form with large canines is not necessarily an anthropoid ape, as used to be assumed—*Pithecanthropus* has shown us that early man also had large canines.

It is precisely for the critical period in the evolution of man, immediately before the Ice Age, that we are so short of serviceable material—a shortage that also applies to the anthropoids, which are very meagrely represented in these strata. We are much better informed about the Lower Pliocene, and here we know so many small, medium and large "anthropoid apes" from the Siwalik levels of India, that we cannot escape the impression that this is a centre of capital importance in evolutionary history. That is why I believe we may expect decisive finds in the foothills of the Himalayas and the Late Tertiary levels of Java.

We learn not only from history, but also from natural history. We have rummaged through the geological past and seen that our present state was not "given", but has "become". It is not for us to evaluate man as an intellectual being, as a poet and thinker; such an approach must be made on a different plane. It is impossible to go as far back as we have done here on any but a natural-scientific basis. Does this make man any the less human? Certainly not: we have merely got to know him from a different angle, that is all, and this only makes the picture of man more definite and more real. The palaeontologist, even if he is committed to hard facts, seeks more than the debris of the past: behind the fossil he seeks life, and behind life order and law. The life of man therefore remains what it

is: an expression of the highest conformity with natural law. As old Hooton once wrote: "We need not give man and his ancestors the credit of developing their own intelligence, but if a human being is not a manifestation of an intelligent design, there is no such thing as intelligence."

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